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CHARLES W. PRICE
PRESIDENT AND TREASURER
STEPHEN H. GODDARD
SECRETARY
CHARLES T. CHILD
TECHNICAL EDITOR
RUSSELL HOWLAND
GENERAL REPRESENTATIVE

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We hear a good deal from the newspapers about the genius of inventors or about such and such an inventor being a wizard or having remarkable creative qualities of brain. As a matter of fact this is not always or even generally the case. Genius is "the capacity for taking infinite pains," and of this sort of genius the successful inventor must have more than his share. The history of nearly all the great inventions shows that they are products not of happy inspiration but of hard and devoted labor extending often over a long period and in the face of great difficulty. The real genius of the inventor is his ability to work—his patience and industry and his indomitable perseverance under the most adverse conditions.

THE FOURTH AVENUE TUNNEL.

A considerable discussion has lately sprung up in the daily papers of New York city concerning the condition of the tunnel leading northward from the Grand Central Station in New York city and the proper remedy to be applied. Two of the heaviest traveled suburban and through systems of railways in the world make use of this tunnel, and a very great number of trains pass through it, causing the air of the tunnel to be loaded with combustion gases, and making it exceedingly disagreeable, if not—at seasons of close weather—actually dangerous to traverse. The remedy universally suggested is electric traction. To this the railway managements interested are alleged to have replied that the operative conditions now existing can not be met by electrical appliances as they now exist.

Leaving entirely aside the accuracy of this statement, it is exceedingly doubtful if it would be desirable under any conditions much longer to continue the operating conditions which mark the station and tunnel referred to, even with steam traction. The main difficulties with the Grand Central Station and its approaches are the handling of a very large number of trains of different classes in an inadequate yard and a "dead-end station." It is not possible for a train to pass through this station, but it must back out after discharging its passengers, causing considerably more switching and handling than would be necessary if the station were of the through pattern, in which the tracks continue out both sides. The solution which seems most likely, therefore, to commend itself to railway operators of experience is the abandonment of the Grand Central Station as the actual terminus for local and through passenger business of the various railroads entering it, and the construction of a large through station with loop tracks and platforms at some point in the northern part of the city where convenient connections could be made with the existing system of elevated railways, surface cars and the subway railroad now under construction. In this way the service through the tunnels and to the present station at Forty-second street, as well as the local suburban service, could be maintained by electric trains, while the through expresses would be steam operated, as at present, to the transfer station. It is true that this plan would necessitate changing cars by the passengers at the new station, but it is exceedingly likely that this change would be welcomed, inasmuch as it would give passengers the opportunity to alight from the express trains and connect with any of the various local transportation services that they might desire. Such a point as High Bridge recommends itself immediately for this purpose, there being abundant room for the construction of a large distributing station on comparatively low-priced ground and easy connections with the various local transportation agencies mentioned.

Even, however, should it be determined not to abandon the Forty-second street station for express service, there seems no insurmountable difficulty in the way of handling the express trains by electric locomotives through the tunnels and properly switching the steam locomotives to them at convenient points several miles out. The Baltimore & Ohio Tunnel Railroad service in the city of Baltimore has been in operation constantly since 1895, and it is stated on competent authority that not one single train has ever been "lost" through its operation. At present an experiment with a sectional third-rail system is being undertaken in the endeavor to cheapen the maintenance costs of the system of overhead construction originally adopted, and which was necessarily somewhat crude, the art at the time of its erection being nowhere nearly so well developed as it is to-day. There would be no insuperable difficulty in constructing an efficient and satisfactory over-

head system over the entire yards and terminal tracks and through the tunnels from the Grand Central Station to Mott Haven on one side and Spuyten Duyvil on the other. A large power plant would be necessary for the operation of these trains and, of course, the suburban service for, say, thirty miles out on the various radiating railroads would naturally be operated by electricity if such a change is made.

It is believed, confidently, that the additional cost of operation imposed by this system would be amply offset by the great gain in local passenger business that would follow it. It is a conservative estimate that Westchester County would increase in taxable valuation by an amount to be reckoned in hundreds of millions of dollars in case a better approach to it should be constructed.

TELEPHONES AND THE PUBLIC.

The relation of any telephone company to the general public is a subject about which much misunderstanding has been common and which is, as yet, perhaps, too little understood by both parties in interest. The very excellence of telephone service has bred captiousness of criticism in the public, which all too often finds expression in complaints for which there is no adequate ground. The fact that one can, through the agency of the telephone, communicate to very great distances and almost instantaneously, is forgotten sometimes when the necessary delay, often of a few seconds, in obtaining connections causes an irascible subscriber to comment on the slowness of the telephone in general and of his local management in particular. As a matter of fact the speed in telephone exchange service seems to be, in modern exchanges, about as high as it is likely ever to be. With every subscriber that is added to the exchange service the complexity of the whole undertaking is increased and the difficulty of promptly obtaining a through connection is made greater. As exchanges have grown, and often as they have become hampered for lack of room for extension or from outgrowing their switchboard capacity, slight delays in service have arisen, and these, instantly recognized by the public, have called down upon the management extensive blame when really the fault is in large part due to the users of the telephones themselves. There are just two ways to increase the speed of exchange service, or, in other words, to reduce the time required to obtain an answer from the persons called. One of these is to introduce the best methods and cultivate the highest efficiency in the operation at the exchange itself. The other and more important one is to train subscribers to answer the telephone immediately when the bell rings. Of the delay in obtaining connections perhaps two-thirds may fairly be said to belong to the called subscriber who takes his time about answering his calls.

It is very likely that the future will see a great extension of telephone communication. Indeed, the time is not so far distant when the telephone will become a common and necessary appurtenance of every residence and place of business having any claim to even moderate importance. This state of things will make the telephone exchanges of the future far more complex than they are now and, unless some new methods which are not at present in sight are devised for handling exchange business, must inevitably lead to somewhat slower work in the exchange itself. This, however, can certainly be more than offset by training subscribers to answer their calls with promptness, thus doing away with one of the most fertile causes for trouble between the central office and its patrons.

The modern exchange switchboard is as nearly automatic as such an instrument can be. The time required to perform the necessary movements for making connections on it has been reduced to the absolute minimum, and the intelligence required has been reduced in the same proportion. The pressure of business necessity has compelled exchange managers to engage a better class of operators to-day than was found in former years. This means more courtesy and better attention to subscribers' wants and greater alertness in giving the desired service. As a whole, telephone service has remarkably improved in the last five years, but there has not been a corresponding improvement in the habits of telephone users, and it is to these that we must look in the future more than to the exchanges themselves for betterments tending to quicken the speed of the telephone's operation.

POLYPHASE TRACTION.

From recent accounts in the lay press it appears that our European brethren in the craft have had much success with the operation of electric railways by polyphase currents used directly on the moving motors. It is deeply to be regretted that this movement could not have been inaugurated in this country where the conditions are, if anything, even more suitable for the application of alternating current to electric railroading than they are on the other side of the Atlantic.

It is pretty well demonstrated that, for a crowded service of frequent trains making many stops, the direct-current system is better than any system using alternating current which is at present possible. But when it comes to a question of high-speed operation over long distances with few stops the reverse is true, and the alternating motor possesses points of great superiority, not alone in its own operation, but also because the trouble, difficulty and expense of converter substations are eliminated from consideration. In the United States we have many examples of the kind of railroad upon which polyphase traction would prove most efficient and satisfactory. A recent news despatch states that the Canadian Pacific Railroad intends to equip with electricity its Rocky Mountain division whereon great difficulty has been experienced in handling freight by means of ordinary steam locomotives. The grades are difficult, and trains have to be broken to allow the locomotives to haul them; fuel is expensive and water power is abundant. Here, then, is an ideal situation. To a lesser degree the same is met in a number of our trunk-line railways operating across the Alleghany Mountains. Upon many of these lines there is a vast business in freight and passengers, particularly in heavy freights, such as coal. The whole tendency of modern railroading has been to make the train unit for transportation of these gross freights as large as possible, and locomotives have grown until they are as heavy as the best roadbeds can safely bear. Even with these monstrous machines, however, there is difficulty found in handling heavy freight trains, and helpers have to be employed on grades or trains have to be broken in two and handled in detail.

THE THEORY OF ALTERNATING DYNAMO ELECTRIC MECHANISMS—XXXVII.

BY W. ELWELL GOLDSBOROUGH.

When dealing with a system consisting of two parts, one a simple circuit in series with two branch circuits, it is best first to assume that a certain electro-motive force is impressed upon the branch circuits, and develop the phase diagram for the circuit as a whole in accordance with this assumption. A final adjustment of the diagram to the requirements of actual conditions can then be readily effected by making a proportional change in the length of each of the vectors. In the present case, to determine the phase diagram which results when generator E^I is acting alone, we will commence by assuming that 250 volts are impressed upon the branch circuits OA_2 and OA_3 at the terminal points O′ and O. Laying off, then, in Fig. 99, $O'A_1^I$ equal to 250 volts, we can erect upon this vector the electro-motive-force triangles of the component circuits. Since, by Equation 54, the current flowing in the circuit OA_1 will be

$$I_2^I = \frac{250}{\sqrt{8.2^2 + 16.6^2}} = 13.5 \text{ amperes},$$

the ohmic and reactance electro-motive forces present in the circuit will be respectively 113 and 224 volts; therefore, we can lay off $O'C_2^I$ equal to 113, and $C_1^I A_1^I$ equal to 224; then, in phase with $O'C_2^I$, the current vector $O'B_2^I$ can be laid off equal to 13.5. In the same way, the electro-motive-force triangle of the circuit OA_3 can be constructed, resulting in $O'C_3^I = 224$ volts, $C_3^I A_1^I = 113$ volts, and $OB_3^I = 9.9$ amperes.

If, now, we take the resultant of the currents $O'B_2^I$ and OB_3^I, we find that they combine to give a current of 22.2 amperes. This current will be that flowing in the line OA_1 and through the armature of generator E^I. To force this current through the resistance and reactance of the circuit OA_1 will require a considerable voltage. Its value is determinable by laying off $A_1^I C_1^I = I_1^I r_1 = 335$ volts parallel to $O'C^I$, and then erecting at C_1^I a perpendicular to $A_1^I C_1^I = I_1^I x_1 = 335$ volts. $A_1^I A^I = 474$ volts will then be the electro-motive force required to set up the current I_1^I in the circuit A_1O. From the diagram now constructed, we find that these conditions will be imposed upon the system only when $E = O'A^I = 722$ volts. The data pertaining to the diagram is given below under Case I.

Now, to construct the vector diagram which shows the exact conditions which prevail when E^I is developing an electro-motive force of 1,200 volts, we must lengthen the vectors of Fig. 99 in the ratio of 722 to 1,200. When this is accomplished, the numerical result will be that given under Case III. The diagrammatical result will be that shown in the left-hand part of Fig. 101. Here $O'A^I = E^I = 1{,}200$ volts. The current flowing in the generator armature $= O'B_1^I = 37$ amperes. The current flowing in the circuit $OA_2 = O'B_2^I = 22.4$ amperes, and, finally, the current flowing in the circuit $OA_3 = O'B_3^I = 16.5$ amperes.

When the second generator E^{III} is developing 1,000 volts and is impressed upon the system, the conditions are such that the circuit A_3O is in series with the parallel system consisting of OA_1 and OA_2. In dealing with this part of the problem, we can not do better than assume, first, an electro-motive force of 250 volts impressed upon parallel circuits; therefore, in Fig. 100, $O'A_3^{III}$ is laid off to equal 250 volts. Then, by applying equation 54 in the determination of the current flowing in the circuit OA_1, the electro-motive-force triangle $O'C_1^{III}A_3^{III}$ is constructed. Here $O'B_1^{III} = 11.8$ amperes, the initial value of this branch current. Similarly, the branch current set up in the circuit A_2O = the vector $O'B_2^{III} = 13.2$ amperes. The combined effect of these currents is to produce a line current equal to $O'B_3^{III} = 23.8$ amperes. This is the current which flows through the circuit A_3O and the armature of alternator E^{III}. To set up this current in A_3O requires an electro-motive force $A_3^{III}A^{III}$, which is the resultant of the resistance electro-motive force:

$$A_3^{III}C_3^{III} = I_3^{III} r_3 = 534 \text{ volts, and}$$
$$C_3^{III}A^{III} = I_3^{III} x_3 = 266 \text{ "}$$

Therefore, $A_3^{III}A^{III} = 596$ volts. The electro-motive force E^{III} which will produce the results shown in Fig. 100 is $O'A^{III} = 825$ volts, since this is the resultant of the partial electro-motive forces $O'A_3^{III}$ and $A_3^{III}A^{III}$.

DATA PERTAINING TO EXAMPLE 20.

Case I.—Circuit No. I in series with circuits Nos. II and III in parallel. Generator E^I running.

$E_1^I = 474$ volts	$E_1 r^I = 335$ volts	$E_1 x^I = 335$ volts	$I_1^I = 22.2$ amperes
$E_2^I = 250$ "	$E_2 r^I = 113$ "	$E_2 x^I = 224$ "	$I_2^I = 13.5$ "
$E_3^I = 250$ "	$E_3 r^I = 224$ "	$E_3 x^I = 113$ "	$I_3^I = 9.9$ "

and $E^I = 722$ volts.

Case II.—Circuit No. III in series with circuits Nos. I and II in parallel. Generator E^{III} running.

$E_1^{III} = 250$ volts	$E_1 r^{III} = 179$ volts	$E_1 x^{III} = 179$ volts	$I_1^{III} = 11.8$ amperes
$E_2^{III} = 250$ "	$E_2 r^{III} = 110$ "	$E_2 x^{III} = 220$ "	$I_2^{III} = 13.2$ "
$E_3^{III} = 596$ "	$E_3 r^{III} = 534$ "	$E_3 x^{III} = 266$ "	$I_3^{III} = 23.8$ "

and $E^{III} = 825$ volts.

Case III.—Circuit No. I in series with circuits Nos. II and III. Generator E^I developing 1,200 volts.

$E_1^I = 788$ volts	$E_1 r^I = 557$ volts	$E_1 x^I = 557$ volts	$I_1^I = 37.0$ amperes
$E_2^I = 416$ "	$E_2 r^I = 187$ "	$E_2 x^I = 372$ "	$I_2^I = 22.4$ "
$E_3^I = 416$ "	$E_3 r = 372$ "	$E_3 x^I = 187$ "	$I_3^I = 16.5$ "

Case IV.—Circuit No. III in series with circuits Nos. I and II. Generator E^{III} developing 1,000 volts.

$E_1^{III} = 303$ volts	$E_1 r^{III} = 216$ volts	$E_1 x^{III} = 216$ volts	$I_1^{III} = 14.3$ amperes
$E_2^{III} = 303$ "	$E_2 r^{III} = 133$ "	$E_2 x^{III} = 267$ "	$I_2^{III} = 16.0$ "
$E_3^{III} = 721$ "	$E_3 r^{III} = 646$ "	$E_3 x^{III} = 322$ "	$I_3^{III} = 28.8$ "

Case V.—Generators E^I and E^{III} running synchronously. Generator E^I developing 1,200 volts, and generator E^{III} 1,000 volts.

$E_1 = 936$ volts	$I_1 = 44.4$ amperes
$E_2 = 426$ "	$I_2 = 22.8$ "
$E_3 = 772$ "	$I_3 = 31.0$ "

Now, from Fig. 100 and the data just given (it is tabulated under Case II), the final vector diagram corresponding to the actual conditions which obtain when E^{III} is developing, 1,000 volts instead of 825 volts is determined by increasing the lengths of the vectors of Fig. 100 in the ratio of 825 to 1,000. The numerical result of this calculation is given under Case IV, and the graphical result is represented in the lower right-hand part of Fig. 101. The record now shows that the electro-motive forces acting on the parallel circuits are equal to $O'A_3^{III} = 203$ volts. The electro-motive forces acting on the circuit A_3O are equal to 721 volts.

The branch current in $OA_1 = 14.3$ amperes, and the branch current in $OA_2 = 16$ amperes, while the armature current flowing in $E^{III} = 28.8$ amperes.

In Fig. 101 we have all the data presented for the final solution of the problem. In accordance with the rule, it is now only necessary to take the vector resultant of the currents flowing in each of the three lines, and these resultants will give the final current values. When E^I is acting, the current $O'B_1^I$ flows in OA_1, and when E^{III} is acting, the current $O'B_1^{III}$ flows in OA_1; therefore, $B_1^{III}B_1^I$ equals, both in amount and phase position, the final current which will flow in the circuit OA_1. In the same way, $B_3^IB_3^{III}$, which is the resultant of $O'B_3^{III}$ and $O'B_3^I$, is the final value of the current flowing in the circuit OA_3. Scaling the diagram, $B_1^{III}B_1^I = 44$ amperes and $B_3^IB_3^{III} = 31$ amperes. The current flowing in the circuit OA_2 is determined by taking the vector sum of the currents $O'B_2^I$ and $O'B_2^{III}$. Graphically, then, $O'B_2 = 22.8$ amperes is the value of the current flowing in this circuit.

Now, the electro-motive forces apparent at the terminals of the three component circuits can be determined either by applying equation 54 and substituting the current and line constants of each circuit, or directly by graphical means. The former method gives us

$$E_1 = 44.4 \sqrt{\overline{15}^2 + \overline{15}^2} = 936 \text{ volts},$$

936 volts as the final electro-motive force apparent at the terminals A_1 and O; and so on for the other circuits.

Graphically, we have that the drop in the circuit A_1O, due to E^I acting alone, equal to the vector $A_1^IA^I$, while the drop in this circuit, due to E^{III} acting alone, is equal to the vector $O'A_3^{III}$. Taking the resultant of these vectors, we have OA^I equal to the electro-motive force sought, which, by measurement, is 936 volts.

In the same way, the resultant of $A_3^{III}A^{III}$ and $O'A_1^I$ gives us OA^{III} equal to 772 volts, the electro-motive force apparent between the points A_3 and O of Fig. 98; and, finally, taking the resultant of the electro-motive forces $O'A_1^I$ and $O'A_3^{III}$, we get OO' equal to 136 volts, as the electro-motive force impressed at the terminals of the middle circuit.

Finally, in Fig. 102, we have a clear representation of the vector relations of the several quantities involved, and, from this diagram, which is produced from Fig. 101, the phase relations of the currents and electro-motive forces are readily determined. We see that OB_1 lags 45 degrees behind OA^I and 63 degrees behind $O'A^I$. OB_3 lags 26 degrees behind OA^{III} and only three degrees behind $O'A^{III}$. Finally, OB_2 lags 63 degrees behind OO'. Now, the power developed in the circuit OA_1 equals

$$E_1 \times I_1 \times \cos \phi_1 = 936 \times 44.4 \times .707 = 29{,}370 \text{ watts},$$

the power developed in the circuit OA_2 equals

$$E_2 \times I_2 \times \cos \phi_2 = 426 \times 22.8 \times .447 = 4{,}340,$$

and the power developed in the circuit OA_3 equals

$$E_3 \times I_3 \times \cos \phi_3 = 772 \times 31.0 \times .894 = 21{,}390,$$

the sum of which is equal to 55,100 watts.

On the other hand, since OB_3 is quite nearly in phase with $O'A^{III}$, generator E^{III} develops

$$E^{III} \times I_3 \times \phi^{III} = 1{,}000 \times 31.0 \times .998 = 30{,}700 \text{ watts},$$

while, since OB_1 lags considerably behind OA, the generator E only develops

$$E^I \times I_1 \times \phi^I = 1{,}200 \times 44.4 \times .458 = 24{,}400.$$

However, the combined power developed by the two machines is equal to the combined power absorbed in the three circuits,

$$24{,}400 + 30{,}700 = 55{,}100.$$

The figures here given are in line with the general suggestion made in connection with Fig. 103, when it was pointed out that a two-phase system, such as that diagrammatically shown in Fig. 98, does not admit of effective working when it is desirable to maintain an equal load on the two generators. *This problem will be explained and dealt with more fully.*

Electricity in Gold Mining.

The Crown Mountain Gold Mining Company, which is operating near Dahlonega, Ga., has recently solved the problem of sluicing its ores by the use of electricity. Twelve miles distant from the point where the company is operating its mill there is a waterfall on the Chestatee River. An electric power plant was erected there, and a pumping station was placed on the banks of the river at the foot of Crown Mountain, and a 10-inch pipe was laid to a reservoir on the summit, 560 feet higher than the mill station. The reservoir has a capacity of 750,000 gallons, and the triplex pump, propelled by electricity, easily forces 1,500 gallons of water per minute up into the reservoir. This reservoir now furnishes an abundance of water for sluicing of the ores of the company.

To produce baryta by electrolysis heavy spar and coal are heated together in an electric furnace. Part of the barium sulphate is first reduced to sulphide, which then reacts with the excess of barytes, forming baryta. When the cold mass is lixiviated the baryta can be crystallized out from the solution.

Wireless Telegraphy.

Colonel Eugène de Pilsondski, an engineer of the Russian Army, has recently made some interesting experiments, using the earth as a conductor. The apparatus was about one kilometre apart, and messages were transmitted clearly, rapidly and without the slightest hitch. The current passes from the transmitter to an underground plate, and then to a box containing the insulating elements, pitch and petroleum, whence it is carried to the receiver at a distance and read off by a Morse apparatus, which in turn reproduces the communications transmitted back to the starting point. A demonstration of the feasibility is shortly to be made between Paris and Compiègne, and immediately afterward between Paris and Brussels. The radius of action depends upon the power of the electrodes, but Colonel de Pilsondski declares that messages can traverse not only mountains and streams, but more easily still the sea. With a potential of 1,500,000 or 2,000,000 volts he maintains that messages can be transmitted from Havre to New York. This system, like that of Mr. Marconi, is based on the Hertzian waves.

Simplified Liquid Interrupter.

Herren D. A. Goldhammer and J. J. Ariston describe a new arrangement of Caldwell's interrupter, which appears to have some distinct advantages. It is thus described in one of Mr. Fournier d'Albe's abstracts: The porcelain diaphragms are represented by the walls of porcelain beakers. The wall is bored down until it is thin, and then a small hole is punched into it by a light tap with a hammer on a needle. This gives holes from 0.2 millimetre to 4 millimetres wide, with walls a few tenths of a millimetre thick. The durability of the porcelain is something quite extraordinary, and indicates porcelain as the ideal material for interrupters of this kind. The beakers used by the authors are 10 cm. wide and 10 cm. high. This insures that for ordinary currents there is very little heating of the liquid. To still further reduce the heating the authors employ two or more cells in parallel, joining the inner vessels with a syphon. If the current passes in opposite directions in the interrupters any change of level in one of the inner vessels will be compensated by a rise or fall of the liquid in the other. As a further advantage, the resistance of the interrupter is diminished. No cooling device is needed in this arrangement. The liquid is covered with a layer of vaseline oil. The cost of the apparatus is trifling.

Selected Chapters in Electrochemistry.

By Harry C. Jones.

CHAPTER III—SOME APPLICATIONS OF THE THEORY OF ELECTROLYTIC DISSOCIATION.

HAVING TRACED in the preceding chapter how the theory of electrolytic dissociation arose, and a few lines of evidence pointing to the conclusion that it expresses a great truth, we must now ask of what service the theory has been. Has it pointed out methods of dealing with new problems, or has it furnished us with new methods of dealing with old problems? Has it suggested new lines of investigation, or has it been able to correlate facts which were apparently disconnected? If it has accomplished any one of these things it is valuable; if it has accomplished more than one, so much the greater its value.

In this chapter we shall aim to show how the theory of electrolytic dissociation has been applied to a few problems, mainly of a chemical nature, and what is the character of the results obtained.

THE NEUTRALIZATION OF ACIDS AND BASES.

A chemical reaction which is about as familiar as any other is the neutralization of an acid by a base. It has long been known that whenever an acid and a base are brought together, each neutralizes the other and a salt is formed. The process of neutralization was looked upon as a special act for each acid and each base, the nature of the process depending upon the nature of the acid used and upon the nature of the base used. It was recognized, to be sure, that in neutralization of acids by bases water is always formed, but this was regarded as of secondary importance. The formation of the salt was the important feature, and this was different for each acid or each base employed. The result of the study of neutralization was, then, the collection of a great mass of more or less disconnected details, between which no very close relations were recognized.

Since the theory of electrolytic dissociation was proposed, we regard the whole process of neutralization in an entirely different light. An acid is represented by the general expression,

$$RH = \bar{R} + \dot{H},$$

where R is the negative ion (anion) and differs for every acid, the positive ion (cation) hydrogen is the same for every acid, and is the constituent which is essential to acidity. Whenever we have an acid in the presence of a dissociating solvent like water, we have hydrogen ions formed, and, conversely, whenever we have hydrogen ions present we have acidity. A base, in terms of our theory, is to be represented thus:

$$R'OH = \dot{R}' + \bar{O}H,$$

R′ being the cation of the base, which differs for every base employed, and the anion, OH, is common to all bases. Wherever we have a base in the presence of water we have hydroxyl ions, and the converse is also true that wherever we have hydroxyl ions we have basic properties.

What takes place, in terms of our theory, when an acid is brought in contact with a base? The anion of the acid, which, as we have seen, varies from acid to acid, and the cation of the base, which is the variable quality for the base, remain in exactly the same condition after the acid and base are brought into contact as before. The only act which takes place is the union of the hydrogen ion of the acid with the hydroxyl ion of the base, forming a molecule of water. These facts would be formulated thus:

$$\bar{R} + \dot{H} + \bar{O}H + \dot{R}' = \bar{R} + \dot{R}' + H_2O.$$

This is very simple, but the fundamental question still remains, is it true? At first sight it appears that it can not be true, because we know that when an acid is neutralized by a base, a salt is formed. The above statements and the formula do not take into account at all the formation of any salt. How is this apparent discrepancy to be accounted for? It is accounted for very readily on the ground that our earlier conceptions of the formation of salts from the action of acids on bases are in error. When a dilute solution of an acid acts on a dilute solution of a base, there is not the slightest reason for supposing that any salt whatever is formed; and we are dealing with dilute solutions of both compounds in order that both may be completely dissociated. It is true that we obtain a salt from the mixture of an acid with a base, by evaporation; but this does not prove, and, indeed, is not the slightest reason for supposing, that a salt exists as such in the dilute solution of the mixture. Indeed, if we take the very salt which is obtained by evaporating the mixture of the acid and base, and prepare a dilute solution of it, the solution will contain no molecules whatever of the salt, but only the ions into which the molecules have dissociated. This alone would show that the old conception of neutralization must be in error, and is a strong argument in favor of the general correctness of the view expressed by the above equation.

We must, however, analyze the above conception more closely. According to the new view, all that takes place in the neutralization of an acid by a base is the union of the hydrogen ion of the acid with the hydroxyl ion of the base. This assumes, of course, that hydrogen and hydroxyl ions in the presence of one another do combine. If we look around for experimental confirmation of this assumption, we find an abundance of it. Space will not permit of a discussion of these experiments, but there are no less than six or seven separate and independent lines of investigation, every one of which has shown that hydrogen and hydroxyl ions can not exist in the presence of each other to any appreciable extent uncombined. Experiment and theory are thus in perfect accord on this point.

Since the process of neutralization consists in nothing but the union of the hydrogen ions of the acid with the hydroxyl ions of the base, then one process of neutralization is exactly the same as any other—the neutralization of any acid by any base is exactly the same as the neutralization of any other acid by any other base. This point can also be tested experimentally. If all processes of neutralization are the same, consisting in the formation of a molecule of water, then the heat which is liberated when an equivalent of an acid acts on an equivalent of a base must be the same as the heat set free when an equivalent of any other acid acts on an equivalent of the same or any other base. This conclusion is beautifully confirmed by experiment. It has long been known that the heat which is liberated when a dilute solution of a strong acid acts on a dilute solution of a strong base is a constant, independent of the nature of the acid, and independent of the nature of the base. This will be seen from the following results:

HEAT OF NEUTRALIZATION.

HCl	+ NaOH	=	13,700 cal.
HBr	+ NaOH	=	13,700 cal.
HNO_3	+ NaOH	=	13,700 cal.

Varying the nature of the base and keeping the acid constant, we have:

$HCl + LiOH = 13{,}700$ cal.
$HCl + KOH = 13{,}700$ cal.
$HCl + \frac{1}{2} Ba(OH)_2 = 13{,}800$ cal.
$HCl + \frac{1}{2} Ca(OH)_2 = 13{,}900$ cal.

The thermal measurements furnish a beautiful confirmation of the theory, being constant, independent of the nature of the acid, and independent of the nature of the base, to within the limits of experimental error.

The story is, however, not yet complete. Suppose that either the acid or the base is not completely dissociated, and still more, that both are incompletely dissociated, what would take place, in terms of our theory, in these cases?

If either the acid or base is not completely dissociated, then, as the ions already present are used up, more and more of the undissociated molecules will break down into ions, until the dissociation has proceeded to the limit, and the neutralization is complete. The dissociation of the originally undissociated molecules, however, is accompanied by thermal change, heat being usually liberated as dissociation proceeds, but in some few cases heat is absorbed. The heat of neutralization would, therefore, be accompanied by the heat of ionization of the compounds in question, and the heat of ionization varies with every compound used.

In such cases, then, where either the acid or base is incompletely dissociated (and still more where both are incompletely dissociated), the heat which is set free when the two are brought together is not simply the heat of neutralization, but this, plus the heat of ionization, which is usually a positive quantity.

If we neutralize a weak* acid with a weak base, our theory would lead us to conclude that the heat set free would not be a constant for different substances, but would vary both with the nature of the acid and the nature of the base.

And since the heat of ionization is usually positive, it would lead to the conclusion that the heat of neutralization of weak acids and bases would generally be greater than that set free when strong† acids are neutralized by strong bases. The following facts confirm very beautifully the conclusions from the theory.

HEAT OF NEUTRALIZATION.

$HF + NaOH = 16{,}270$ cal.
$H_3PO_4 + NaOH = 14{,}830$ cal.
$CHCl_2COOH‡ + NaOH = 14{,}830$ cal.

* "Weak" acids or weak bases simply mean substances which are only slightly dissociated.
† "Strong" means great dissociation.
‡ Dichloracetic acid.

The theory of electrolytic dissociation, then, not only applies to the cases where the heats of neutralization are constant, but is equally applicable to those other cases where the heats of neutralization are not constant, and which would appear at first sight to present exceptions to the theory. Indeed, all of these facts are necessary consequences of our theory, and it would be unfortunate for the theory if they were not just what they have been found to be. We thus see how the theory of electrolytic dissociation accounts for all the facts which are known concerning the neutralization of acids and bases; but it has accomplished what is of far greater importance.

As has already been stated, before the theory was proposed, each process of neutralization presented a new problem, depending upon the nature of the acid and the nature of the base used. It was recognized that water is always formed when acids and bases react, and it was supposed that there is some vital connection between all processes of neutralization; but what this was, was not perceived. The problem was rendered still more difficult by the supposed fact that in the process of neutralization a salt is formed, and this must be different for every acid and base which is used. Since a different product is obtained with each process of neutralization, it seems impossible to refer all processes of neutralization to anything like a common cause.

We now know that all processes of neutralization of acids and bases are essentially the same, consisting only in the formation of a molecule of water. A more or less heterogeneous mass of facts is referred to a common cause, and thus correlated in a manner which would have been impossible without the theory of electrolytic dissociation. We shall learn that other great masses of facts have been dealt with in a similar manner, and generalizations reached through this great generalization, which are, in fact, but corollaries of it.

STRENGTHS OF ACIDS AND BASES.

From the footnotes of an earlier part of this paper it would be gathered that there is a close relation between the "strength" of compounds and the amounts of their dissociation. This subject is of such importance that it must be taken up more fully. Before the theory with which we are dealing came into vogue, the term "strength" was applied to chemical compounds in a more or less indefinite way. Various methods were adopted and used for determining the strengths of substances, and the results obtained depended largely upon the method which was employed. It was thought for a long time that of all the acids, sulphuric is the strongest. This idea arose apparently from the fact that sulphuric acid is such a vigorous reagent on all forms of organic matter, and, further, because sulphuric acid readily replaces many other acids from their salts. This erroneous conclusion was, then, arrived at chiefly through a method which is not a sufficient test of the strengths of chemical compounds. This method is insufficient, chiefly because in the displacement of one acid from its salts by another acid a number of factors come into play besides the relative strengths of the two acids. Thus, one of the compounds may be volatile and escape from the field of action as soon as it is formed, and this alone is sufficient to determine the direction and magnitude of the reaction; or one of the substances may be insoluble, and, as is well known, this is quite capable of conditioning the entire course of the reaction. As an example of the first case, take the action of sulphuric acid on chlorides of metals whose sulphates are soluble. We know that sulphuric acid can drive out practically all the hydrochloric acid from such compounds, the latter escaping from the field of action as a gas as rapidly as it is formed. Examples of insoluble compounds being formed and conditioning the entire course of the reaction, are so numerous that it may seem superfluous to select any one example. A whole class of illustrations is furnished by the action of the very weak acid, hydrogen sulphide, on the salts of strong acids with the heavy metals. Thus, hydrogen sulphide will precipitate copper, lead, mercury, etc., as sulphides, from their salts with the very strongest acids, such as hydrochloric and nitric. The number of illustrations of this principle is almost limitless; indeed, qualitative analysis in organic chemistry is made possible by, and based directly upon, this principle. Enough has, however, been said to show that the method involving the displacement of one substance from its compounds by another is alone not a sufficient criterion of the relative strengths of the two substances.

A number of other methods have been devised and used for determining the relative strengths of substances, but these, like the above, are either insufficient in principle or are difficult to carry out in practice.

The theory of electrolytic dissociation has thrown entirely new light on this whole problem. The dissociation of the dif-

ferent acids has been worked out* on the one hand, and then their chemical activity, and the two sets of results have been compared. The following are a few of the results which have been obtained for some of the more common acids. In column I are given the dissociations of the acids referred to hydrochloric acid as 100; in column II the chemical activity of the acids as measured by the velocity with which they are capable of effecting a certain reaction.

	I	II
Hydrochloric acid	100.0	100.0
Hydrobromic "	101.0	98.0
Nitric "	99.6	92.0
Sulphuric "	65.1	73.9
Acetic "	0.42	0.34
Monochloracetic acid	4.9	4.3
Dichloracetic "	25.3	23.0
Trichloracetic "	62.3	68.2
Oxalic "	19.7	17.6
Succinic "	0.58	0.50
Tartaric "	2.28	2.30

The agreement between the dissociations of the acids and their chemical activity is unmistakable.

The following are a few of the results which were obtained from some of the best known bases. Column I gives the dissociation, II the chemical activity:

	I	II
Potassium hydroxide	161.0	161.0
Sodium "	149.0	162.0
Ammonium "	4.08	3.0
Methylamine	20.02	19.0
Ethylamine	20.05	19.0
Dimethylamine	23.05	22.0
Trimethylamine	9.07	7.03
Tetraethylammonium hydroxide	128.0	131.0

Here, again, an unmistakable agreement exists.

To determine the relative strengths of compounds, at present, it is only necessary to measure their relative dissociations; but this is only a small part of the benefit to be derived from the theory in dealing with reactions in which these substances take part. Let us take some reaction which is effected by all acids, say, the inversion of cane sugar in the presence of water. This reaction takes place in the presence of hydrogen ions—the common constituents of all acids—as follows:

$$C_{12}H_{22}O_{11} + H_2O + \overset{+}{H} = C_6H_{12}O_6 + C_6H_{12}O_6 + \overset{+}{H}$$

giving one molecule of dextrose and one of levulose.

The velocity with which this reaction will take place, other things being equal, depends upon the number of hydrogen ions present; *i. e.*, upon the dissociation of the acid. If we know the dissociations of different acids we can tell at once just how fast they would invert cane sugar, or accomplish any similar reaction; and, conversely, we can measure the dissociations of different acids by measuring the velocities with which they effect any given reaction like the above.

The remarks which have just been made concerning acids apply with equal accuracy to bases. Take any reaction which is effected by the hydroxyl ion—the common ion of all bases—such as the saponification of an ester, which takes place in the sense of the following equation:

$$CH_3COOC_2H_5 + NaOH = C_2H_5OH + CH_3COONa.$$

The velocity with which this reaction will take place depends upon the number of hydroxyl ions present; *i. e.*, upon the dissociation of the base. If we know the dissociation of different bases we know the relative velocities with which they will effect the above reaction; and, conversely, if we know the relative velocities with which any given bases will effect the above reaction we know their relative dissociations or strengths; since the two are proportional.

We can thus use dissociation to measure the chemical activities of substances, or we can use chemical activities to measure dissociation, since, as we have seen, a proportionality exists between the two.

CATALYTIC REACTIONS.

We can not pass over the above reaction between cane sugar and water, in the presence of acids, without making a slight digression from our general theme, to call attention to one peculiarity which exists. It will be observed that in the equation for this reaction the hydrogen ion is written in the same condition on the two sides of the equation. This means that it does not enter as such into the reaction. If it does not enter into the reaction, why is its presence necessary in order that the reaction should take place with any appreciable velocity? We can not at present answer this question, but it seems probable that the action of the hydrogen ion is a *surface action*. In the light of this conception it acts by contact, and such actions of substances, of which many are known, are termed *catalytic*. While we at present do not understand the mechanism of catalytic reactions, the problem is considerably simplified through the existence of the theory of electrolytic dissociation. Before this generalization had been proposed it was known that acids could effect certain catalytic reactions, but it was supposed that these reactions were produced by the whole molecules of the acids. We know now that the molecules of acids, as such, are not capable of producing catalytic reactions, but that it is the hydrogen ion into which the molecule dissociates, which acts catalytically—the anion of the acid taking no part whatever in the reaction.

The observations which have just been made in reference to the catalytic reactions of hydrogen ions apply with equal force to the catalytic reactions of hydroxyl ions. The hydroxyl ions of bases can effect certain reactions catalytically, just as the hydrogen ions of acids, and the same rules which hold in the one case apply also in the other.*

COMPARISON OF REACTIONS BETWEEN INORGANIC SUBSTANCES AND ORGANIC SUBSTANCES.

It has long been known that inorganic substances in general have a much greater chemical activity than organic. This is shown very well in the relative velocities of the two sets of reactions. Inorganic reactions proceed so rapidly that in most cases it is impossible to measure their velocities. Indeed, their velocities are frequently so great that they usually have been regarded as taking place instantaneously.

It is, however, quite different with organic reactions. They proceed, relatively, very much more slowly than inorganic, and in many cases their velocities are sufficiently small to enable them to be readily measured.

Why does this difference exist? A few years ago it would have been impossible to furnish a satisfactory answer to this question. It might have been said that inorganic reactions proceed more rapidly because the substances are chemically stronger, but this would have been simply renaming the phenomena, and not an explanation at all.

To-day we not only have a rational explanation of these facts in terms of our theory, but they are also a necessary consequence of it. Inorganic compounds are much more strongly dissociated than organic. Indeed, the inorganic acids and bases are the most strongly dissociated substances of which we have any knowledge, and the salts are, as a class, among the most strongly dissociated substances. This applies to even the salts of the metals with weak acids, and the salts of strong acids with weak bases. Since chemical activity is proportional to dissociation, the most strongly dissociated substances must be the most active chemically.

Take the organic compounds, a great majority of them are dissociated very slightly, if at all; and even the organic acids and bases are among the weakly dis-

* One practical method of measuring dissociation was referred to in Chap. ii, based on the lowering of the freezing point of solvents by dissolved substances. This will be considered more fully, and another method described in Chap. vi.

* For some interesting cases of the catalytic action of finely divided metals, see recent work of Bredig and his pupils, *Ztschr. phys. Chem.*, 1900-1901.

sociated substances. The strongest of the organic acids is not as strong as sulphuric acid, which is only about three-fifths as strong as nitric or hydrochloric acid; while most of the organic acids are of the order of strength represented by acetic, malic, or tartaric acid; *i. e.*, scarcely more than a few hundredths the strength of the strongest mineral acid. The same general remarks apply to the organic bases, though, perhaps, to not quite the same extent.

The organic compounds being, then, only slightly dissociated, react much more slowly than the inorganic; more ions being formed as the few already present are used up in the reaction, and this continuing until the end is reached, or more frequently, until equilibrium is established between the velocities of two opposite reactions.

Our theory furnishes us with a perfectly satisfactory explanation of all of these facts.

CHEMICAL ACTIVITY DUE TO IONS.

We have seen in the preceding paragraphs that chemical activity and dissociation are proportional to one another. If chemical activity is proportional to the number of ions present, then what part do the molecules play in chemical action? This question naturally forces itself upon us. To answer it we must exclude molecules, on the one hand, and see whether ions react; and, on the other, we must exclude ions, and see whether molecules can react or not. To exclude molecules it is only necessary to prepare very dilute solutions of strong acids and bases, since in such solutions all the molecules are dissociated into ions. It has been seen that in *solutions which are completely dissociated,* taking into account the amount of substance present, the *chemical activity is a maximum.*

This would indicate either that ions alone can enter into chemical activity, or, at least, are much more active than molecules. To decide between these alternatives we must exclude ions altogether and see whether molecules have any chemical activity. This can be accomplished by excluding all traces of moisture and other solvents which have any dissociating power. The great experimental difficulties involved have been overcome in a number of cases* with the following results. Only a few cases can be taken up here: Dry hydrochloric acid gas does not decompose carbonates to any appreciable extent, and it does not precipitate silver nitrate dissolved in anhydrous benzene or anhydrous ether. It does not change blue litmus red, nor does perfectly anhydrous sulphuric acid.

Dry hydrochloric acid gas does not react to any extent upon dry ammonia gas. In such an experiment it is, of course, necessary to take the greatest precautions in drying the gases, by allowing them to come in contact with the most powerful drying agents, under the most favorable conditions, for a long period of time. This is a very surprising fact, but is even surpassed by the following experiment. Dry sodium can be dipped into sulphuric acid, from which every trace of moisture has been removed, without any appreciable action taking place. In this experiment, also, the greatest precautions must, of course, be taken to remove every trace of moisture from the substances, and from the vessels in which the experiments are to be carried out.

These experiments would show that molecules such as we have been considering do not have the power to react chemically; but these experiments alone do not justify the conclusion that other molecules may not react chemically, or that molecules under other conditions may not react. Any conclusion on this point could be drawn only after an elaborate study of chemical reactions in general, under very widely different conditions.

The result of such a study has, however, made it very probable that *molecules can not react chemically with molecules.* It is possible that molecules may react with ions, but this is not proved.

It is very easy for any one whose knowledge of the facts is not very comprehensive to think they have found examples of chemical activity where there are no ions present; but it should be remembered that not only water but most other solvents have some ionizing power, although this differs greatly from solvent to solvent. Furthermore, heat has a very great power of breaking down molecules into ions; fused salts being very considerably dissociated.

THE TWO GREAT GENERALIZATIONS.

In the first chapter we traced the discovery of the generalization that the gas-laws apply to the osmotic pressures of solutions; in the second and third, the origin of the theory of electrolytic dissociations and a few of its applications to chemical problems.

It is difficult to overestimate the importance of these generalizations for modern physical, and especially chemical, science. Upon them has been built most of the science of modern physical chemistry, of which electrochemistry is only one chapter. It is not an exaggeration to say that every important development in electrochemistry, in the last dozen or fifteen years, has centred around one or the other of these generalizations, or around both.

The remaining chapters of this series of papers will be devoted to a discussion of some of the more interesting and important advances which have been made in electrochemistry since these generalizations were discovered.

* For a full discussion of this problem, see Theory of Electrolytic Dissociation, pp. 160–170.

International Association of Municipal Electricians.

Arrangements have just been completed whereby some papers of great importance will be read before the sixth annual convention of the International Association of Municipal Electricians, which will be held at Niagara Falls, N. Y., September 2, 3 and 4, 1901. The main subject for discussion will be the "Advisability of Placing High and Low-Potential Wires or Cables in the Same Series of Conduits." This is a lively subject and at present is an interesting topic in the section of the country in which the meeting is held, particularly at Rochester, N. Y.

Arrangements are also nearly completed whereby the new Edison storage battery and the Stowager storage battery, which hails from Rochester, will be exhibited for the first time. Over 100 well-known electricians and electrical supply dealers from New York will join the party leaving Sunday, September 1, at 7.30 P. M. This party will be in charge of Mr. Frank C. Mason, superintendent of police telegraphs of the Borough of Brooklyn, who has the matter in charge and who will be glad to give any further information desired in connection with it.

American Street Railway Association.

The annual convention of the American Street Railway Association will be held in Madison Square Garden, New York city, on October 9, 10 and 11. Already so many applications for space have been made by those desiring to exhibit in the building at the time of the convention that it has been necessary to reduce the space of applicants for more than 100 square feet by 20 per cent. No reduction has been made in cases where 100 square feet or less have been asked for.

The direction and superintendency of exhibits have been placed in the hands of Mr. Marcus Nathan, well known as a successful manager of such exhibits, and communications on the subject of exhibits should be addressed to him at the Grand Central Palace, Lexington avenue, New York city. It is expected that a large attendance will be had this fall and Mr. T. C. Pennington, the treasurer, states that the outlook for a fine convention is excellent.

American Electro-Therapeutic Association.

The American Electro-Therapeutic Association will hold its eleventh annual convention in Buffalo on September 24, 25 and 26, 1901. Its headquarters will be at Hotel Niagara, anl its place of meeting at the armory of the Seventy-fourth Regiment. Dr. George E. Bill, of Harrisburg, Pa., is secretary of the society, and will furnish any further information desired.

The Rochester Telephone Company's Equipment.

A Typical Modern Telephone Plant for a City of Medium Size Exchange, Lines and Equipment of a Model Independent Company.

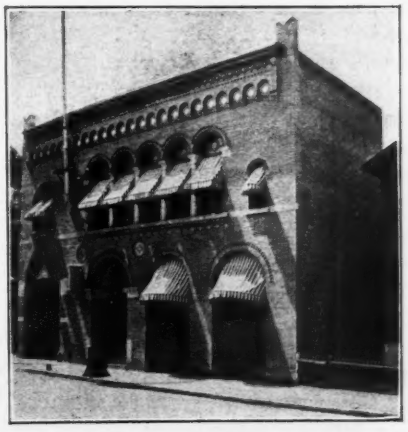
AT ROCHESTER, N. Y., the Rochester Telephone Company was organized a little more than two years ago by gentlemen of that city for the purpose of conducting a telephone central exchange. The exchange was opened for service in May, 1900, with 1,500 subscribers, and has grown until to-day it has 3,800 subscribers in Rochester proper, and over 4,000 connected with its exchange through toll-lines extending to 26 towns in the immediate vicinity.

THE MAIN SWITCHBOARD IN THE ROCHESTER, N. Y., INDEPENDENT TELEPHONE EXCHANGE.

The physical equipment of this company is marked by great thoroughness and an unusual attention to the design of the plant with reference to the duties it is called upon to perform. A building designed for the purpose was erected at a central point, this structure being entirely fireproof, and containing not only operating rooms and the general offices of the company, but also stock rooms and quarters for the engineering and superintending departments. The building is a plain structure of brick, two stories high, and is easily accessible on three sides, rendering the delivery and outgo of supplies exceedingly easy. All of the lines enter the building through conduits terminating in a room in the basement, where are located the cable heads.

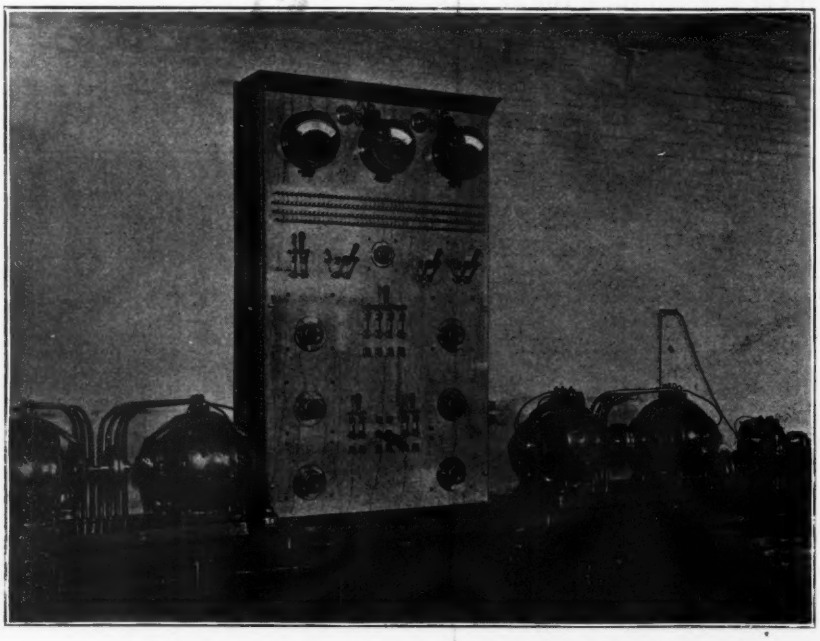
The system adopted by the company is the central energy type of telephone appliances manufactured by the Stromberg-Carlson Telephone Manufacturing Company, of Chicago, the switchboard being of the full multiple type.

One of the illustrations shows the power plant which furnishes current for charging the storage batteries and for operating the ringing dynamos. This plant, as well as every other part of the company's equipment where duplication can be practiced, is built in two distinct and separate parts, so that one is always available in case of accident to the other. The motor-generators supplying current to charge the storage battery system, each consist of two machines, identical in size, one operating as a motor from the 220-volt mains of the electric light supply of Rochester, and the



BUILDING OF THE ROCHESTER TELEPHONE COMPANY.

other, coupled to it through an elastic insulating joint, supplying current at 40 volts for charging purposes. These machines, which are of about 1.5 kilowatts capacity, were manufactured by the Roth Brothers & Company, Chicago. Three



Power Equipment and Switchboard in the Rochester Exchange.

"ringers," which are motor-dynamos taking direct current and giving out single-phase alternating current of proper frequency for bell ringing, are provided, these being, respectively, of 40, 110 and 220 volts on the direct-current side, so that they may be operated from the battery, from one side, or across both sides of the city three-wire lighting system. In this way it is always possible, even should the electric light supply service be interrupted, to maintain the ringers in operation.

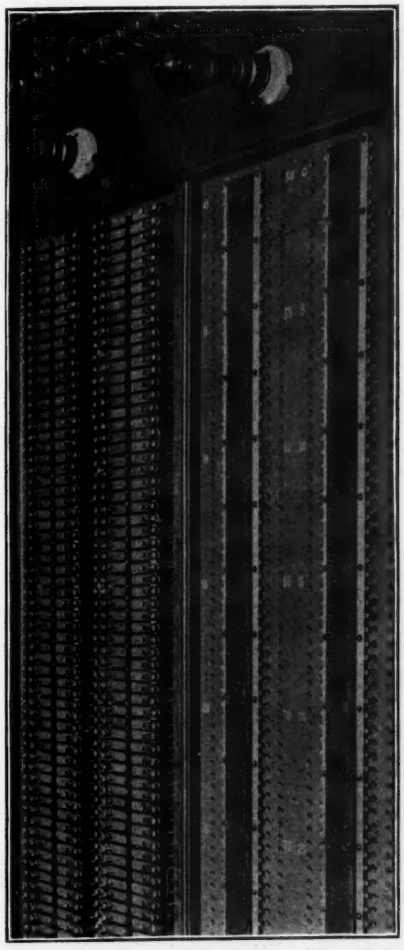
A totalizing ampere meter on the storage battery circuit furnishes a very convenient and interesting index of the current required for all purposes in this plant. The battery itself consists of two sets of 20 cells each, of the American Storage Battery Company's make, each cell having a capacity of 360 ampere-hours. It is customary to use the two sets alternately, one being charged while the other is working. With the ringing machines running on the battery circuit the maximum demand for current for operating the entire plant has not yet exceeded 15 amperes, or a total of 600 watts—less than one horse-power to maintain talking and ringing service for over 4,000 telephones. The smallness of this current output is also a very fair indication of the excellent insulation resistance of the entire system.

On the ground floor are situated the distributing board and lightning and foreign current arrester board. The distributing board is of an exceedingly simple type and is so well shown in the illustration as to require no further description. The lightning arrester board is a highly ingenious piece of work. The various circuits pass from the distributing board to the lightning arresters, which are of the Rolfe heat-coil type, so arranged that they can instantly be removed and new ones substituted. It is possible by removing any one of these arresters and inserting a test-plug in its place to bring the circuit to which it belongs to the testing operator's desk, thus permitting the easy and satisfactory testing of any circuit without in any way disturbing a soldered connection. The lightning arresters are so arranged that in case of their action the line is grounded, and at the same time a red lamp, placed over the section of the lightning arrester board to which it belongs, is illuminated and an alarm signal given, calling attention to the trouble on that line. The heat-coils are set so as to act when their temperature reaches 140 degrees Fahrenheit, and are normally capable of holding a steady current of 0.1 ampere, acting when this rises to 0.25 ampere. From the lightning arrester board the circuits rise in cables to the back of the main operating switchboard on the second floor of the station. The rear of this board is shown in one of the illustrations.

The equipment at present is for 3,600 subscribers' lines on the main board, 100 lines terminating at each operator's position. An electrical restoring visual type of signals is used, the main line indicators being mounted in rows of 20 on the upper part of the board back of the ground glass plates shown above each operator's position in the large illustration. These signals are displayed in the clear glass spaces in the board when subscribers remove their receivers from their hooks, and are automatically restored when the operator inserts the answering plug in the corresponding spring-jack. Clearing-out signals consist of incandescent lamps placed in the plug circuit, while the pilot light on the face of each section of the board is illuminated whenever a call comes in to

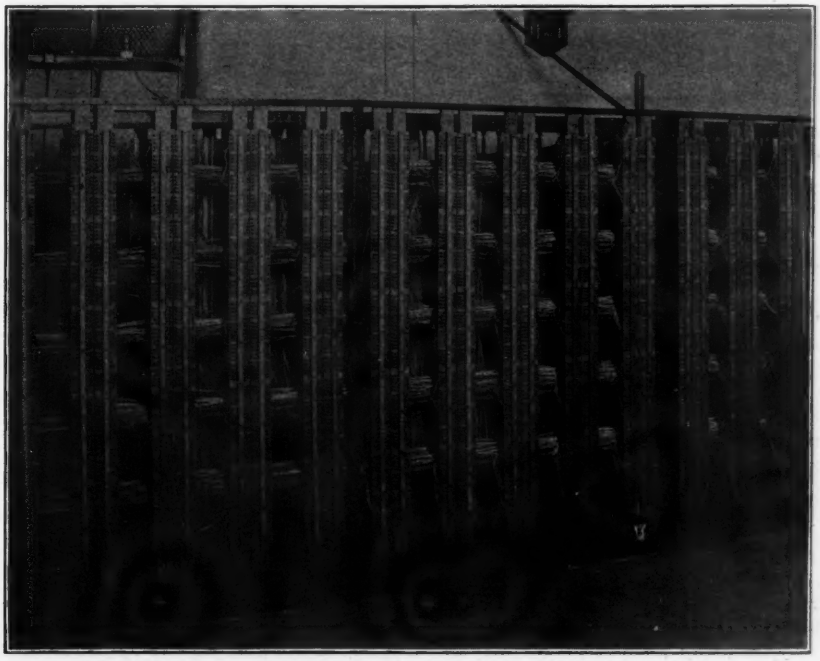
The Storage Battery of the Rochester Exchange.

that operator's position. The operators' head telephones are each provided with a flexible cord and a plug for attaching them to a spring-jack underneath the plug shelf on the board, and each operator is provided with her own individual head telephone. In the same room with this main board and facing it are the two desks of the chief operator and the supervising operator. On the desk of the latter is placed a board containing 36 miniature signal lamps, one being connected with each operator's position at the main board and lighting whenever a call comes in at that particular position. These remain lighted until the call is answered. Another row of lights on the same board is



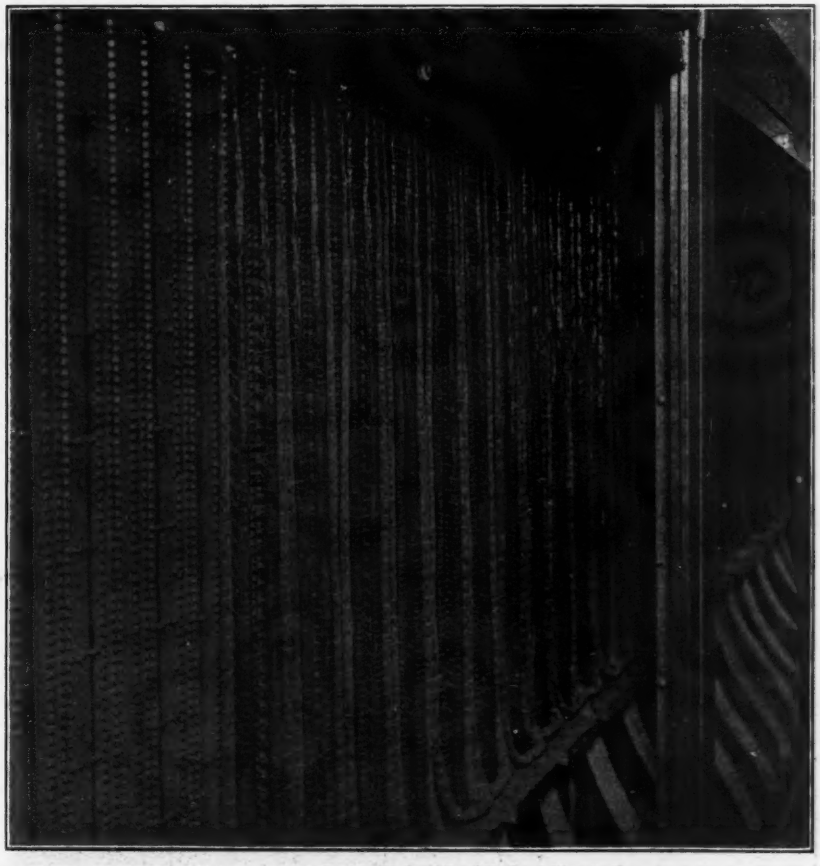
Detail of the Lightning Arrester Board, Showing Removable Heat Coils and Signal Lamps.

illuminated so long as the disconnecting signal is being made at each operator's position, and are extinguished when the operator makes the disconnection. A third row of lamps is so connected that each remains lighting while its particular operator is ringing a called subscriber. In this way the supervising operator has complete supervision of the length of time required

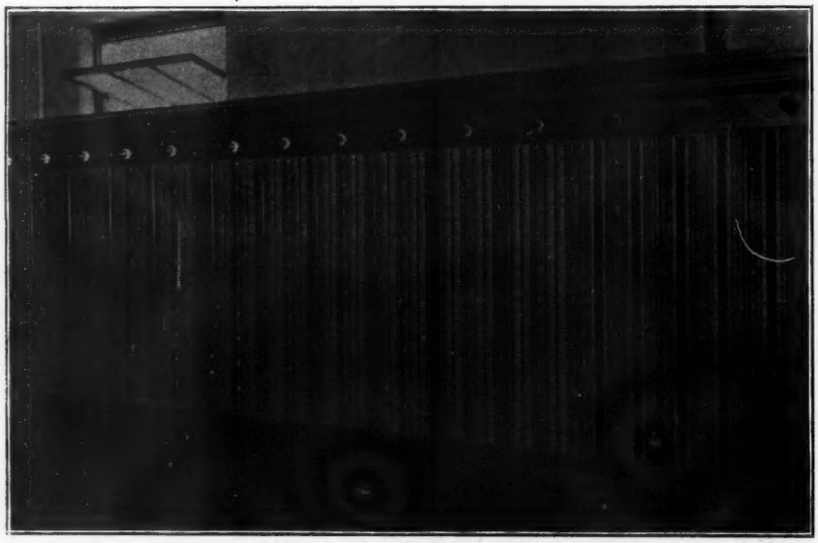


Distributing Rack, Rochester Telephone Company.

by any individual board operator to perform the various functions required in her service. This desk is also equipped with circuits to each of the operator's positions, enabling conversation with the individual operators. The chief operator's desk is provided in the usual way with means for communicating with any of the various sections of the board. The rear of the main switchboard is closed with sliding dust-proof curtains to prevent the accumulation of dust, and the whole board is



Back of the Main Switchboard, Rochester Telephone Exchange.



THE LIGHTNING ARRESTER AND TESTING BOARD.

constructed in a substantial and rigid manner.

The operating room is large, light and airy, and from it opens a retiring room, with a matron in charge, wherein various comforts are provided for the operators. In all 72 young women are employed in this service, 36 working at once on the day shift.

The cable terminal room in the basement is so well shown in the illustration as to require no comment. The cable heads are of the usual iron variety, all of the cables and their auxiliary parts having been made by the Standard Underground Cable Company, of Pittsburgh. These cables are of the dry paper variety and are used by the company in sizes of 200, 150, 100 and 50 pairs. The whole are laid in clay conduits made by the H. B. Camp Company, of Akron, Ohio, the following being approximate lengths of cable installed July 15, 1901: 200 pair, 80,500 feet; 150 pair, 45,000 feet; 100 pair, 53,000 feet; 50 pair, 74,000 feet; total, 252,500 feet.

On account of the conduit system of the city of Rochester being controlled by a corporation different from the telephone company, the latter has found it necessary to operate its lines in the same general conduit system with cables used for carrying electric light, power and railway current. Contrary to the expectations of some, no trouble whatever has been encountered from this source, the lines being noticeably quiet with very little extraneous buzzing or noise indicating foreign current. In all of the 50 miles of cable now underground it is stated that only six circuits are "dead."

CABLE VAULT OF THE ROCHESTER TELEPHONE COMPANY.

The cable system is carried out very extensively, distributing lines being confined to comparatively short lengths and for the most part are installed on the centre block system. One of the illustrations shows distribution from a circular pole top, these pole tops consisting of a stout oak

POLE-TOP DISTRIBUTION FROM CIRCULAR FIXTURE, ROCHESTER.

wagon felly about five feet in diameter and carrying 24 pins. This is secured to the pole tops by means of a wrought-iron frame. The points are of steel, with locust tops, and carry pony glass insulators.

Practically all of the distributing wiring is done through No. 14 gauge twisted copper pairs manufactured by the John Roebling's Sons Company. A very small amount of iron wire is used in some outlying districts for temporary circuits until the permanent construction can replace it.

At present the Rochester Telephone

Company is rapidly extending its lines into the adjacent districts, its toll service at present embracing the country within a radius of 20 miles around Rochester. The following towns are at present connected with the system, all of them being in New York state:

Adams Basin, Barnards, Beckwith, Brighton, Brockport, Charlotte, Chili, Clarkson, Despatch, Fairport, Garland, Greece, Honeoye Falls, Irondequoit, Mendon, Mendon Center, North Greece, Parma, Penfield, Pittsford, Sea Breeze, Spencerport, Summerville, Rochester Junction, West Greece and Windsor Beach.

No electrolytic or other troubles have been encountered so far in the operation of the very large cable system maintained by this company. The sheaths of the cable are connected at intervals to heavy copper return circuits in the conduits, this having a tendency to maintain the potential of all the various cables at practically the same point. On account of the extraordinary perfection of the outside installation it is found necessary to employ only two line-trouble men and four inspectors in the whole city. For the benefit of the latter the city is divided into districts, each containing about 1,000 telephones, to each of which one man is assigned. The line-trouble men are sent out as required from the exchange.

The whole of this admirable system was constructed under the designs and supervision of Mr. C. E. Stinson, the company's general manager. Mr. C. O. Harris was the superintendent of the construction department. Other officers of the company are as follows: Frederick Cook, president; E. H. Satterlee, vice-president; George R. Fuller, secretary and treasurer; M. F. Babcock, contracting agent.

Convention of the Independent Telephone Association of Southern Indiana.

The Independent Telephone Association of Southern Indiana held its second annual convention at Maennerchor Hall, New Albany, Ind., Thursday and Friday, August 1 and 2. The object of this association is like that of other similar bodies in the independent telephone field. Its first concern is with the protection of independent telephone interests and a considerable part of its discussion was also given to bringing about a reasonable charge for tolls and the rental of telephones.

The first day's session was opened by an address on the part of Mr. C. D. Knoefel, president of the Home Telephone Company, New Albany, to which a suitable response was made by Mr. G. A. Kienle, the president of the association. An address was read by the Hon. E. M. Coleman, of Louisville, Ky., on "Independent Telephone Promotion," and a paper on "The Bell *vs.* the Independent Telephone System" was presented by Mr. George Borgerding, of New Albany. At an evening session an informal reception was tendered the delegates by the officers of the Home Telephone Company, of New Albany.

The second day's session was given over mainly to the reading and discussion of the following papers:

"Free Service, Ought Not There Be a Limit?" by Phil. Dilly, treasurer Dubois County Telephone Company, Huntingburgh; discussion led by T. M. Thomas Lamar. "Is it Profitable to Furnish Telephone Service at 50 Cents per Month?" by J. W. Ladd, Independent Telephone Company, Dale; discussion led by Dr. E. E. Allenbaugh, Huff. "Farmers' Lines, How to Make Them Most Profitable to the Local Exchange," by L. G. Davis, Hoosier Telephone Company, Salem; discussion led by Dr. L. H. Hilsmeyer, Stendal. "Benefits of Metallic Lines Over Grounded System," by Chas. F. Stevens, Princeton.

MR. C. E. STINSON,
GENERAL MANAGER THE ROCHESTER TELEPHONE COMPANY.

After the reports of committees had been received, applications of membership acted upon and officers for the ensuing year elected, an adjournment was taken.

Electric Traction in France.

An article which recently appeared in *Le Genie Civil* gives some instructive facts in regard to the experiences of six French tramway systems which have changed from animal to electric traction, the most prominent feature of which is the large increase in the number of passengers which the roads have carried. In the case of these six lines this increase varied from 37 to 209 per cent. The increase in gross receipts on the French lines were from 49 to 158 per cent. The receipts per car-mile show a decrease varying between 9 and 24 per cent, while the decrease in operating expense per car-mile was between 15 and 35 per cent. Owing to much greater number of car-miles with electric traction, however, the total operating expenses of the lines increased, this increase varying between 36 and 90 per cent. In very case, however, it was less than the increase in gross receipts, so that a gain in net receipts is shown varying between 136 and 1,035 per cent.

Wireless Telegraphy in the U. S. Navy.

A specially appointed board in the United States Navy has been considering wireless telegraphy *versus* homing pigeons. It recommended that the use of homing pigeons be discontinued as soon as wireless telegraphy has been introduced into the navy. The board also suggested that training stations for officers and men be established at the Naval Academy, at Annapolis, and the Washington Navy Yard.

Wireless Telegraphy in the British Navy.

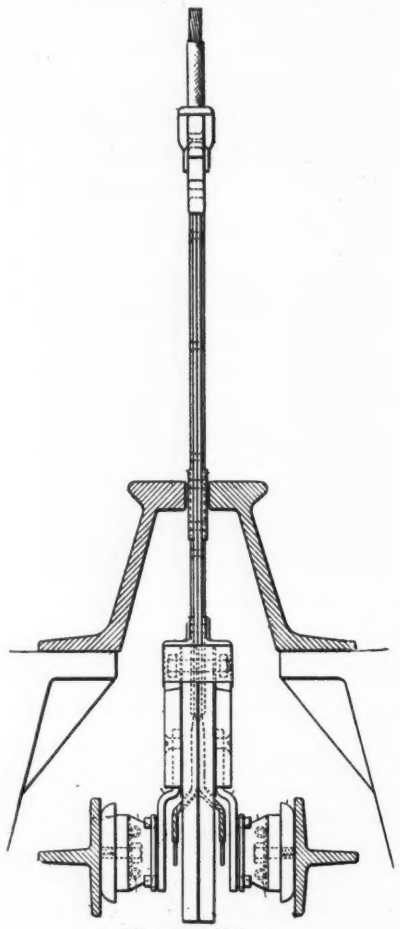
One of the features of this year's naval manœuvres in the English Channel will be the use that is to be made of wireless telegraphy. It is indicated by telegrams from Portsmouth and Devonport that the admiralty are making preparations to a practical test. From Dover to Plymouth, and even round the Cornish coast, it is said, stations will be placed in a state of preparedness for mimic warfare, and will be equipped to communicate with the men-of-war, most of which have been fitted with the now familiar gaff. Ten signalmen, who have gone through a course of instruction at Portsmouth in the new system of telegraphy, have been despatched as operators to the signal stations at Dover, Culver Cliffs, Portland Bill, the Scilly Isles and Roches Point.

Electrolytic Manufacture of Sodium.

In Fischer's process for the electrolytic manufacture of sodium a mixture is made of 75 parts by weight of potassium chloride and 59 of sodium chloride, says the *Electrochemist and Metallurgist*. This mixture is electrolyzed in the electric furnace in a wide shallow crucible with a partition in the middle, which does not, however, reach the bottom. The electrodes are placed horizontally, and pierce the sides of the crucible at opposite ends of a diameter perpendicular to the partition. The cathode side of the crucible is kept cold by a current of water. The anode is a solid carbon rod, and the cathode is a metallic tube, the axis of which is level with the surface of the fused mixture in the crucible. The sodium, which only contains about one per cent of potassium, is removed through this tubular cathode. The advantage of using a mixture of the two chlorides is that, following the usual law, it has a lower fusion-point than either of the chlorides separately; hence the temperature employed can be kept down and the loss of sodium by volatilization is considerably reduced.

Electrical Patents

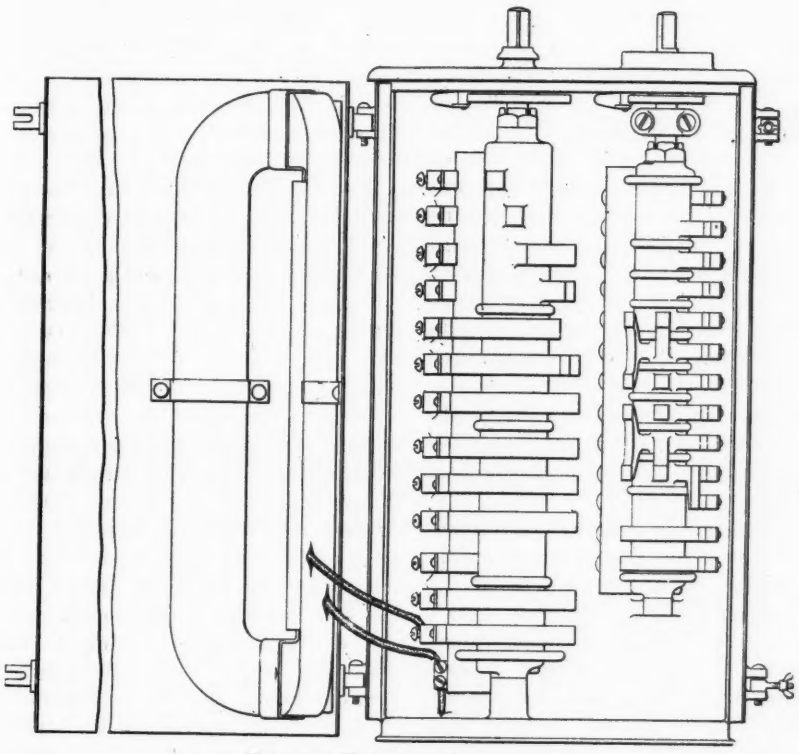
Two rather important inventions relating to electric cars have recently been patented, and are decided improvements over the constructions heretofore employed. The first relates to collector plows, employed in conduit systems in which the supply conductors are mounted upon insulating supports within a conduit beneath the roadbed, and was granted to Mr. J. Hoffman, of Schenectady. This invention relates more particularly to the construction of the shank of the plow and to the arrangement of the cables which lead the current from the collector shoes through said shank to the motor. The improvement resides in making the shank of two sheets of steel which are riveted together, each being provided with two offset longitudinally disposed channels which are of such depth that when the parts are secured together two tubular passageways are formed by the aligned coacting offset channels of each section, to accommodate the cables that lead the current to the car motor. This part of the plow construction is very important and upon it chiefly depends the success of railways of this type. The shank must be sufficiently strong to withstand the extremely rough usage to which it is subjected, it must provide channels large enough for the reception of the two conducting leads, and at the same time it must not be thicker than a maximum of seven-sixteenths of an inch for the roadway slots, which have a maximum width of five-eighths of an inch. In some cases it is necessary to employ a slot having a width of only three-fourths of an inch, and then the plow must not be thicker than one-half an inch. Furthermore, the plow must not be heavy, as any increase in weight increases the strains to which it is subjected, and also it is desirable that the cost of production be as low as possible. Hitherto the shanks for the plows used on the railways above mentioned have been constructed of two flat plates of steel, with metal bracing-strips interposed between them and so arranged as to provide channels for the reception of the leads. The objections to this construction are that the shank is too heavy and a needlessly large amount of metal is used in the filling between the plates. Furthermore, in order to permit the use of wearing-plates of practicable thickness it has been necessary to cut away portions of the outside plates and secure the wearing-plates of proper thickness to the interior bracing-strips. This construction was laborious and costly and also weakened the outside plates. It has also been proposed to construct the shank of two flat plates having longitudinal grooves on their faces to form channels for the leads. This construction has the same defects as that just described and is, in fact, essentially the same, except that it has the additional disadvantage that the parts which form the channels are made integral with the outside plates, which, of course, greatly increases the difficulty and cost of constructing them. In this latter case the shanks are much too heavy, a needlessly large amount of metal is used, and it is necessary to cut away the outside plates in order to suitably secure wearing-plates of proper thickness to the shank. In carrying out the invention above outlined, sheet-metal plates having a thickness of only one-eighth of an inch are subjected to pressure, preferably in a hydraulic press, so as to form the lateral offsets. These plates, thus having a uniform thickness throughout, are then assembled so that the plane portions are in mutual contact and the recesses formed by the offsets are brought opposite to each other to form the channels for the flat leads. The entire thickness of the shank at the offsets is not more than seven-sixteenths of an inch, and the thickness through the mutually adjoining plane portions is one-fourth of an inch. There is thus a saving of three-sixteenths of an inch of metal for the entire width and length of the shank, except at the offsets, which is very material both as to weight and cost. Furthermore, there is sufficient space on each side of the plane narrow portion of the shank to enable the two plates to be secured together by rivets without the necessity of countersunk holes, and, what is of still greater importance, there is sufficient space so that the wearing-plates can be riveted directly to the opposite side of the plane portions, without the necessity of cutting away the plates, as has hitherto been essential with the old construction.



Conduit Plow.

The other patent relates to means for securing the "magnetic blow-outs" within the controller casing, so as to secure a maximum efficiency in its action without obstructing the access to the contact fingers for the purpose of adjustment, etc. The inventor, who is Mr. Emmett W. Stull, of Johnstown, Pa., has found it very desirable, in order to obtain the greatest efficiency from a magnet of given strength, to make the coil embrace or surround a portion of the periphery of the contact-carrying drum in such a manner that the contact ends of the contact-carrying fingers shall be located at or near one of the poles in a space threaded by the greatest number of lines of force passing in a direction perpendicular to the direction of arcs which form between the fingers and the contacts. It is impossible, however, in many controllers to provide a magnet constructed and arranged in this manner without placing the coil in the way of access to the said fingers, which is a serious objection to the controller, and in such cases it becomes necessary to resort to a less efficient arrangement of the coil. The present invention avoids this objection in a very simple manner, by causing the blow-out coil to be attached to a movable or removable (preferably hinged) portion of the controller casing, so that when the said portion is moved or removed to gain access to the interior the coil is moved bodily therewith entirely out of the way. The blow-out coil is a closed coil having its two limbs or branches in planes at right angles to each other, and is secured to the door portion of the casing by straps or other suitable means. Between the two limbs or branches a reinforcement of magnetic material is provided, which extends practically the full height of the coil and forms a pole-

piece adjacent to the series of contact fingers. The coil is connected in series with the motor circuit by means of flexible leads having sufficient slack to permit the door to be opened, one of the leads being connected with the trolley side of the circuit, while the other is connected to the lowermost contact finger. Thus the coil practically surrounds a portion of the periphery of the controller drum, and the fingers are therefore located in the densest part of the magnetic circuit with



Magnetic Blow-Out Controller.

the lines of force passing in such a direction that a very powerful blow-out effect will be exerted upon any arcs which may be formed between the fingers and the contacts of the drum. In case it is desired to obtain access to the interior, the very act of opening the controller casing will move the blow-out coil bodily out of the way and leave the fingers and their connections to the board perfectly exposed.

New Regulations for Automobiles in France.

The French Government requires that every automobile capable of exceeding the legal limit of 30 kilometres (18½ miles) shall have "plaques" at front and rear, bearing a registered number. It restricts the use of the horn to giving warning at dangerous places for avoiding accidents. The horn can no longer be used to clear the road arbitrarily. Without the consent of the mayors of all the communes traversed races can not be run.

INFLUENCE OF OSCILLATIONS ON ELECTROLYSIS.

BY ARTHUR MORRIS.

In a memoir communicated to the *Academie des Sciences,* of Paris, by MM. André Broca and Turchini, the authors state that they have discovered that a disruptive discharge with electrical waves of from 350 to 400 metres in length—*i. e.,* with oscillations at the rate of about a million per second—have very different effects on an electrolyte in the circuit from those produced by an ordinary galvanic current. Under certain conditions—*e. g.,* when the electrolyte is, for an electrolyte, a very good conductor—disruptive sparks of great power are produced in the electrolyte itself. This shows that to oscillations, at least of the particular frequency above mentioned, the electrolyte behaves almost as a dielectric. This is undoubtedly the cause of the transparency of electrolytes to light, a transparency which it was very difficult, nay impossible, to explain by means of the ordinary electromagnetic theory of light.

MM. Broca and Turchini carried out their experiments with a large Ruhmkorff coil excited by an alternating current, and giving an electric arc five or six centimetres (about two inches) long under the conditions existing; *viz.,* 110 volts, 42 periods, 50 amperes. The capacity employed was about 12,500 electrostatic units, and therefore quite sufficient to produce the spark without any blast. The sparks were formed in air, sparking in oil or petroleum being attended with the power used by inconvenient irregularities. If in this circuit an apparatus is introduced suitable for the production of the spark in oil, but containing a good conducting liquid instead of oil, powerful sparks pass with a loud detonation. The sparks are of dazzling luminosity, and appear the instant the brass balls are separated. The balls used by MM. Brocha and Turchini were two centimetres in diameter. At the same time that the sparks pass, gas is evolved. It has hitherto proved impossible to measure the length of these sparks exactly, but it appears to be about two millimetres, or, say, one-twelfth of an inch. If the brass balls are drawn still further apart, the phenomenon ceases, and the discharge spark remains active and therefore disruptive. If the spark-gap in the air is entirely closed, while that in the electrolyte is still open and the sparks are passing through the electrolyte, these sparks also cease. This indicates that they can not be attributed to heating of the electrolyte such as occurs during ordinary electrolysis with currents of very high voltage. MM. Brocha and Turchini add that it is impossible by the means above indicated to produce an active spark in an electrolyte, but that when there is an active spark in the circuit, and of proper length, the spark produced in the electrolyte has very similar characters. Another reason is adduced by MM. Brocha and Turchini for considering that the electrolyte spark is really a disruptive phenomenon. The voltaic arc has the distinctive characteristic that, once the light is produced, the electrodes can be separated to a greater distance without interrupting the circuit and therefore extinguishing the light. On the other hand, when the brass balls in the electrolyte are separated until the sparks are suppressed, they are invariably reproduced by first breaking the external circuit, and then closing it again. Again, even after a few seconds of sparking, the brass balls in the electrolyte have palpably lost substance, and that to a far greater extent than would have been the case if the phenomenon (the sparking) had been produced through the air.—*The Electrochemist and Metallurgist.*

The electro-manufacture of ferro-nickel is contemplated by a few Continental works. Experiments are being made in that direction in Bellegarde (Ain), France.

THUNDERSTORMS.*

BY ALFRED F. SIMS.

In this country, general observations of thunderstorms were made by volunteers under instructions from the Smithsonian Institute as far back as 1849. Since 1871 voluntary and regular observers have made observations under the direction of the United States Department of Agriculture Weather Bureau. The conclusions drawn from the observations are as folows:

(1) Thunderstorms advance from the West toward the East and Southeast; they generally develop in the southeast quadrant of a low atmospheric pressure area and about four to five hundred miles from its centre.

(2) The outlines of the region favorable for thunderstorm development spread in a fan shape toward the Southeast and East.

(3) A thunderstorm travels at less speed than the accompanying area of low atmospheric pressure.

The development of thunderstorms depends, not only on the high temperature of the summer afternoons, but also on the lack of equilibrium of the atmosphere as determined by the circulation of cyclonic winds.

The attendant phenomena of a thunderstorm vary considerably, but are usually as follows: First, cirrus haze appears in the morning. Then dark clouds are seen lying low in the western sky, usually in the afternoon; the air is warm and sultry. Later on the clouds mount to near the zenith, and the air near the ground "A solemn stillness holds." The clouds on the front of the thunderstorm are grayish white or reddish and hang over and in front of the main rain cloud. Above these, dense dark gray and violet cumulo-stratus clouds are seen, also the towering cumulus clouds which are separated from the cumulo-stratus. Often these are interspersed with one or more thick cumulo-stratus cloud layers and above all is the widely distributed cirro-stratus.

The herald of the storm is heard before the cloud reaches the zenith, and the first rain commences after it. The interval between the first thunder and the beginning of the rain varies from a few minutes to half an hour or more. About five minutes before rain begins, there comes from the West or Northwest a brisk wind which suddenly increases in violence and becomes a squall.

The time of heaviest rainfall varies; sometimes it occurs at the beginning and sometimes in the latter part of the time the rain cloud draws over a locality. The lightning strokes and loudest thunder occur some minutes after the rain begins. Gradually the western horizon loses its dark aspect, lightens up a little, and finally opening clouds appear. The storm clouds pass by overhead and the rain ceases shortly before their western edge reaches the zenith. The last thunder is usually heard after the rear edge of the cloud has passed the zenith. The usual direction of translation of thunderstorms in this latitude is easterly, and they revolve around a horizontal axis, whereas tornadoes revolve around a vertical axis.

Before the thunderstorm, the meteorological conditions undergo the following changes: The air pressure and the relative humidity decrease, and the temperature rises; the wind is light. At the moment of bursting of the storm, the air pressure and relative humidity increase very rapidly and the temperature falls; the wind becomes suddenly strong, and sometimes it as suddenly subsides almost immediately afterward, while at times it increases until near the close of the thunderstorm. Toward the end of the thunderstorm, the air pressure and relative humidity reach their maximum, and the temperature its minimum.

The history of a thunderstorm as indicated by a mirror-electrometer is very interesting. On a warm afternoon one sees through the haze to the Southwest a patch of dark cloud about 20 miles away. When the clouds are overhead, a beam of reflected light in the darkened observation room is seen traveling along a ground glass scale.

The little mirror reflecting the light is attached to the electrometer needle, and in this way the most minute movement of the needle is made known.

From the window the nozzle of the water-dropping collector protrudes through a small opening. The wind rises, and we notice the needle moving steadily toward the point marked 1,000 volts positive. This means that the potential between the earth and the cloud is steadily increasing. Suddenly the needle flies to the other side of the scale, and we know that the air has snapped and given way under the strain, the electric stress is negative; *i. e.,* in an opposite direction, and now the needle dances and we hear outside the rumble of distant thunder. Nearer comes the storm. This process is repeated and values of from 3,000 to 10,000 volts are obtained. With every flash of lightning we catch the fleeting reflections of a little spark in the electrometer. If we place the eye close to the little peephole through which the nozzle goes, we shall see the stream of water twisting and breaking into spray and each time there is lightning, quickly becoming normal, only to rapidly twist and distort again.

The severest discharges demolish and destroy by mechanical action and heat, which generate gases and ignite inflammable materials. Mechanical action is not so powerful in smaller discharges, but they may cause fires. The speed of a lightning discharge may account for the difficulty with which it passes through coils of wire or other conductive circuits, without assuming that the discharge is oscillatory. A coil constructed to offer a relatively high resistance to the passage of lightning will allow free passage of all ordinary electric currents.

The air between two clouds charged with electricity, or between a charged cloud and the earth, is subject to an electrical strain. When this strain upon the air column becomes too great a disruptive discharge takes place. This discharge may vary in character from the invisible silent lightning to the violent, impulsive rush discharge which has an enormous amount of energy. The flash may have a duration varying from one-three-hundredth of a second to a second. The lowest point in the cloud formation is where the electrical discharge most frequently takes place, for the reason that it offers the shortest course to the ground.

The distribution of electricity varies with every change in the conditions of the atmosphere. As electricity resides on the surface of a body, when aqueous vapor condenses on dust particles and accretes, the electrical potential of the rain-drop rapidly rises, for the reason that the surface of the rain-drop is smaller than the total surfaces of the small globules which combine to form it.

A heavy shower of rain rapidly carries off the electricity, reducing the potential of a cloud to that of the earth. There are certain states of the atmosphere which give rise to silent electric discharges between pointed bodies and the air.

The electrical energy is mainly converted into heat by the resistance of the air, the particles of which are instantaneously heated. The passage of the electrical current is so rapid that only a brilliant light streak, or flash, is visible.

The intensely heated air expands suddenly, and then as suddenly contracts, setting up a succession of air waves along the line of the flash. The rumble and roar or sharp crackling sound reach the ear according to the distance of the ob-

*From a pamphlet published by the General Electric Company.

server and the direction of the discharge. The sound reverberates from the earth's surface and hills and from clouds.

Vegetable juices of trees present lanes for the electric discharge, and very often the sap between the wood and the bark is so heated by the discharge that steam is generated which bursts the trees, tears away branches, and ploughs deep furrows in the solid wood.

FORECASTING OF THUNDERSTORMS.

There are no infallible rules for forecasting thunderstorms from the daily weather charts. A noticeable feature of the weather charts is the relation of the thunderstorm's belt to the pressure line of 30 inches, and the thermal line of 70 degrees Fahrenheit. A low pressure area to the West, moving in behind a high pressure area, is the region within which thunderstorm conditions are very liable to develop during the afternoon or evening. Thunderstorm conditions are generally found on the edges of low areas and are not noted in the centres. When thunderstorms occur in the southwest quadrant of a low area they are liable to be sporadic in character; their route of march is short, and they soon die out. In heated terms, thunderstorms may be looked for along the line of change in pressure, and where the temperature in the afternoon will continue high. These storms are more liable to occur the day after the maximum heat has passed.

Small thunderstorms which last but a short time are often influenced by the topography of the country, that is, by the mountains and river valleys. The larger storms, which extend upward thousands of feet into the atmosphere, cross mountain and valley and are practically uninfluenced by small isolated hills or river valleys.

Thunderstorm activity often begins almost simultaneously over a rather large region and it may continue intermittently for a day or so, when, without an apparent reason, there is a decided increase in the violence of the storms.

Violent thunderstorms may occur in the same district on two successive afternoons, but this is the exception rather than the general rule.

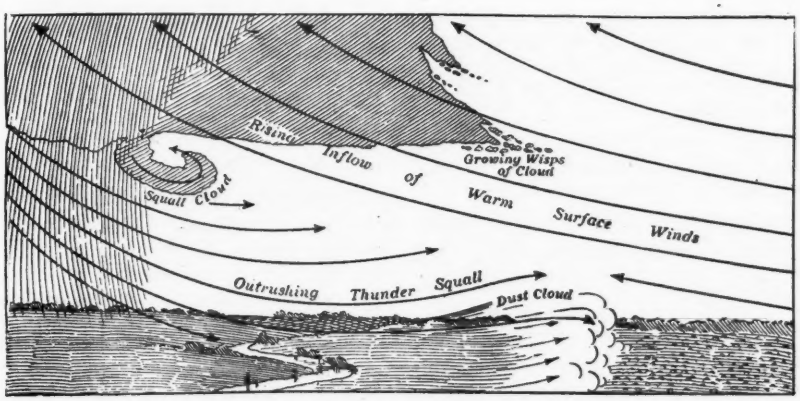
The regions liable to visitation by these manifestations are in general the lake regions, the upper and middle Mississippi Valley, and from Missouri eastward to the Atlantic. Their progressive motion is generally eastward.

The region of the greatest number of thunderstorms is the southeastern part of the United States. From May to June the maximum is in the northeastern and central states, especially in a region extending along the Mississippi Valley.

For July the maximum extends from northern Montana to central Texas, thence to Georgia, and thence northeastward to southern Maine, also in a small area about Lake Huron.

The maximum for August occurs in the vicinity of Salt Lake, Utah, and along the Gulf and Atlantic coasts. The area of maximum frequency of winter thunderstorms is in Louisiana and vicinity.

The general direction of approach in the United States is from the west. At Key West, Fla., the approach is from the east; at Galveston, Tex., from the northeast, north, or southwest.



DIAGRAMMATIC CROSS-SECTION OF A THUNDERSTORM.

A patent has recently been taken out in Germany for the production of ozone by the electrification of the air by a process which, it is claimed, reduces the heat generated, and, therefore, the formation of oxides of nitrogen to a minimum. The apparatus to be preferred has its electrodes covered with a very large number of points and separated by glass plates. The great point appears to be to make the electric discharge as nearly invisible as possible.

Electric Railways in Germany.

Some recent statistics published in Germany give some interesting data concerning the growth of electric railways in the German Empire. On the first of September last there were altogether 99 German cities in which electric tramways were in existence, and it is estimated that on January 1 of the present year there were 107 cities with electric lines. The last 10 years have shown a most remarkable growth. In 1889 only three cities had electric tramway systems. In 1895 the number had grown to 32, and in 1899 there were 88 electric tramway lines. On September 1, 1900, the total length of track was 1,793 miles as against 1,280 miles in 1899. The number of cars in operation on September 1, 1900, was 5,994 as against 4,504 the year previous, and the number of trailers was 3,962 as against 3,138. The aggregate power of these electrical plants on September 1, 1900, was 75,608 kilowatts as against 52,509 kilowatts in 1899. Only three cities in Germany at present have underground conduits, all the other systems having adopted the overhead trolley.

Electromagnetic Theory of Mechanics.

The leading ambition among electrical theorists has been to reduce electromagnetics to mechanical conceptions and principles. This tendency is probably due to the notion that mechanical actions are somehow more real, palpable and intelligible than the play of electrical and magnetic forces. This idea is, of course, quite erroneous, since the intimate mechanism of a simple contact or impact is quite as mysterious as the attraction of two oppositely electrified bodies. The attempt made by Herr W. Wien to reduce mechanics to electromagnetic conceptions and principles is, therefore, of great interest, says the *Electrician*. He assumes, with Lorenz, that gravitation is due to the attraction between the ions composing the material bodies, and that the attraction between positive and negative ions surpasses the repulsion between ions of the same class. The ether is supposed to be at rest. Gravitational force must be propagated with the velocity of light, and must be modified by the motion of bodies. This, in the case of the fastest cathode rays, would involve a modification of seven per cent. The other fundamental property of matters, *viz.*, inertia, would be based upon electromagnetic inertia. These speculations open up wide vistas in mechanics, which will put the theory to a very severe test.

The Summer Meeting of the American Institute of Electrical Engineers.

The first preliminary programme of the summer meeting of the Institute at Buffalo was issued in May. In accordance with the amended constitution this yearly event will hereafter be known as the annual convention.

Replies received from abroad indicate that about 40 European engineers and guests will attend this convention. The dates already announced will be adhered to, as follows:

Wednesday, August 14—Meet at the house of the American Society of Mechanical Engineers, 12 West Thirty-first street, New York city.
Address of welcome to our foreign guests, followed by a collation, registration of names and distribution of badges.

Thursday, August 15—Visit Crocker-Wheeler Works, Ampere, N. J.; power stations of the Manhattan Railway and Metropolitan Street Railway companies, New York city.
Dinner at Hotel Marlborough, Broadway and Thirty-sixth street, in evening. Tickets, $2.50.

Friday, August 16—Visit exchange of the New York Telephone Company, Eighteenth street and Irving place; central stations, New York and Brooklyn Edison companies.

Saturday, August 17—No assignments. Day may be devoted to personal visits.

Sunday, August 18—Party will meet on board special steamboat Montauk, foot of West Forty-second street, New York, at 9 A. M. Proceed up the Hudson River, arriving at Albany about 6 o'clock P. M. The party will be met at the wharf at Albany by special street cars, which will take the members direct to the Ten Eyck Hotel for the night.

Monday, August 19—Leave by special train for Schenectady at 8.30 A. M. Visit works of General Electric Company. Leave Schenectady by special train at 1.30 P. M., immediately after luncheon, arriving at Buffalo about 8 o'clock P. M. Special arrangements will be made for conveying the party from the train at Buffalo to the Hotel Niagara, which will be the headquarters of the members during the convention.

Tuesday, August 20—Opening of convention at the New York State Building, grounds of Pan-American Exposition, 10 o'clock A. M.
Address of welcome by his honor the Mayor of Buffalo. The afternoon and evening will be devoted to a preliminary tour of the exposition.
It is expected that only morning sessions of the convention will be held, the afternoons being utilized as may be arranged by the Buffalo local committee, including a trip to Niagara Falls, visiting stations in Buffalo, etc. General topics for discussion each day have been selected, upon which brief abstracts of papers will be presented, as follows:

Wednesday, August 21—On topics relating to meters and metering of electric energy, by Harry P. Davis, Caryl D. Haskins, Paul M. Lincoln and William Stanley.

Thursday, August 22. *Electric Day*—On topics relating to electric transmission systems; W. S. Aldrich and H. W. Redfield, Wm. Hand Browne, F. A. C. Perrine, E. W. Rice, Jr., Chas. F. Scott, Chas. P. Steinmetz; and "A Description of Niagara Falls Transmission Plant," by L. B. Stillwell.

Friday, August 23—On topics relating to the supplying of light and power in large and small cities; L. A. Ferguson and William Lispenard Robb. "The Nernst Lamp," by Alexander Jay Wurts.

Saturday, August 24—On topics relating to electric railroading, by A. H. Armstrong, E. J. Berg and others.

TRANSPORTATION AND ACCOMMODATION.

The fare for the trip from New York to Buffalo and return will be $16. This will include transportation on the boat, with luncheon and refreshments, and transportation on the train next morning from Albany to Buffalo. It will also include the privilege of sending heavy baggage from New York on Saturday, August 17, from residence in either New York or Brooklyn, with its delivery to hotel room at Buffalo. The return fare will be good for 15 days from date of issue, returning by any train on the New York Central except the Empire State Express, the Lake Shore Limited or the Limited Mail.

The rates at the Hotel Ten Eyck, Albany, will be $3.50 for each person for dinner, breakfast and bedroom, without bath, or $6 for two persons. The rate for similar accommodations with bath in addition will be $4 for each person.

The rates at the Niagara Hotel, in Buffalo, on the European plan throughout, will be $3 for one person, in a single room, without bath; for one or two persons, with bath, in a single room, $8 per day; for large suites, with bath, for one or two persons, $10 to $12.

For those who can not be accommodated at the hotel, good rooms will be secured in the neighborhood at rates not exceeding $2 per day for each person.

As far as possible, reservations will be made in the order of priority of application, and notice will be given promptly of the character and price of the reservation as soon as made.

Applications for tickets and accommodations should be made as early as possible to Mr. R. W. Pope, secretary of the Institute, 26 Cortlandt street, New York. Each application should enclose a check, payable to R. W. Pope, for the number of tickets required, and should specify the accommodation wanted at Albany and at Buffalo.

The rate for those who want only single tickets from New York to Buffalo will be $10, and for those who want single tickets from Albany or Schenectady to Buffalo, $6.50.

The committee urges all members who can do so to join the party in New York city and make the entire going trip.

Members may invite and introduce guests, either ladies or gentlemen, who will be entitled the ordinary privileges of members.

Members from New England may join the party at Albany, although it is desirable that all who can do so should start from New York city.

The French party of engineers, organized by *L'Eclairage Electrique*, after the adjournment of the convention, will leave Buffalo for Chicago on Sunday, August 25, spending Monday and Tuesday in Chicago. Returning to Kingston, Ont., the party will continue down the St. Lawrence, stopping at Montreal, August 30 and 31, and Quebec, September 1.

Leave Quebec September 2 and proceed to New York, *via* Lake Champlain and Lake George, embarking for Havre September 5. Members of the Institute may arrange to join this party, and are also requested to facilitate the investigations of our foreign guests whenever possible.

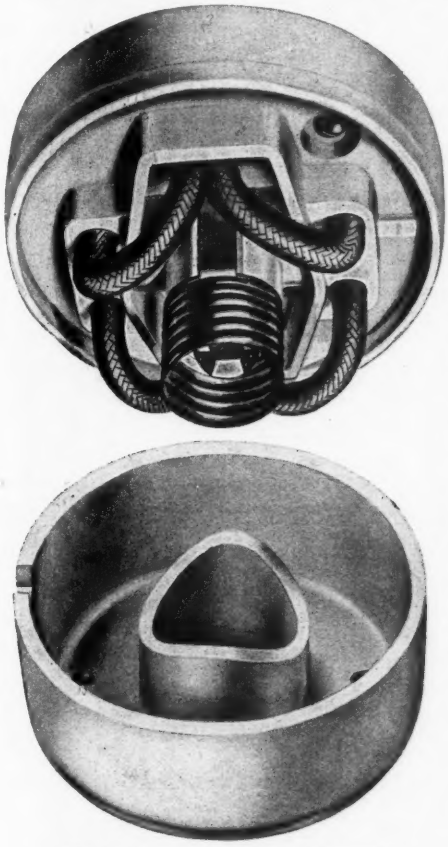
The Engineers' Society of Western New York, through William A. Haven, president, extends to all members of the Institute the courtesy of the society's rooms, 675 Ellicott square, during the exposition season. This is a central location, and all the usual facilities of an office building are available.

News comes from Paris that a company has been formed for the development of the Gerard process of steel manufacture by electrical treatment of the crude ore. The power required per ton of metal is said to be 2,000 horse-power-hours.

A patent has been taken out in Russia to obtain iron direct from the ore by electrolysis. A cathode composed of iron ore is electrolyzed with a solution of common salt. This cathode is either in the form of a powder at the bottom of the cell or in masses formed by pressing the ore into cakes with small coal or heavy petroleum oils. It is said that the hydrogen evolved by the electrolysis precipitates the iron in the metallic state.

Receptacles for Marine Lighting.

One of the most difficult places for the installation of electrical apparatus of any kind is on shipboard. This is particularly true with reference to sockets, receptacles and other small fittings, especially when they have to be put in exposed places. The combination of salt water and salt air has often proved too much for such appliances.

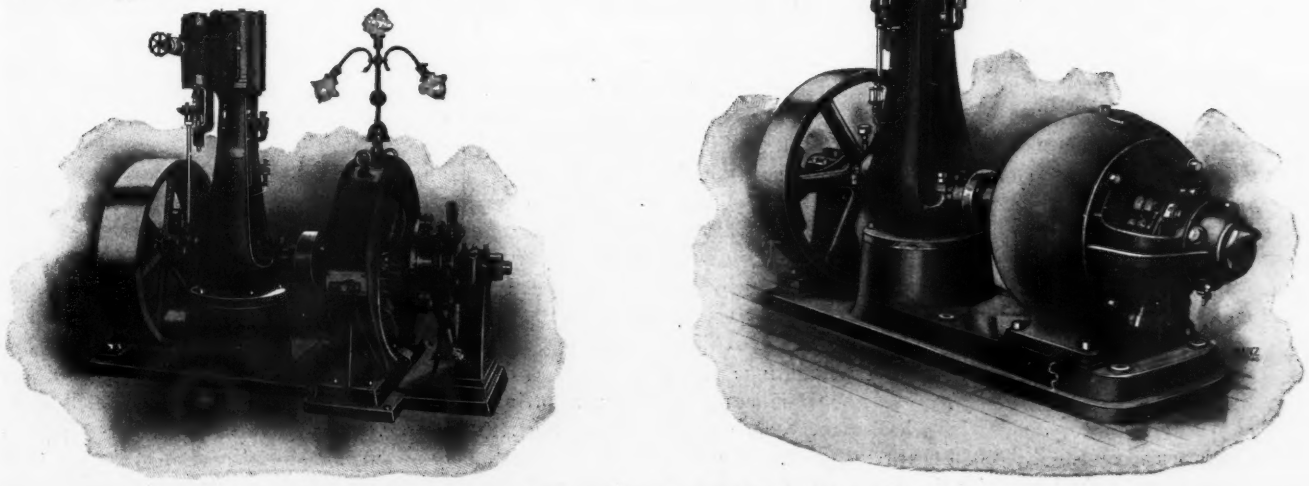


Receptacle for Marine Lighting.

The accompanying illustrations show some types of water-proof receptacles manufactured by the Electro-Dynamic Company, of Philadelphia. This the makers claim to be built on a new principle, inasmuch as it is water-proof. The water-proofing of the device is accomplished by allowing the water to run off in a bight or loop of the conductor through holes provided in the cap. The base and cap are also provided with suitable bosses and barriers to bring about this desired result. The general type of construction is well shown in the illustrations.

Automatic Engines for Electric Lighting.

In the accompanying illustrations are shown two types of automatic engines especially adapted for operating electrical apparatus. These machines are built by the Racine Hardware Company, Racine, Wis., and are claimed by the makers to be especially adapted either for direct coupling or belting. The engines are made in sizes of from 2 to 37 horse-power and possess a number of interesting points. Governing is accomplished by manipulation of the cut-off point through the use of the Rites governor, a machine which combines the centrifugal and inertia methods of operation, and regulation is guaranteed to within one and one-half per cent from no load to full load. For small isolated plants and for marine plants these engines are said to be particularly well suited, as they are of the vertical type, with all the working parts moving vertically, so that the wear is reduced to a minimum, and at the same time the floor space is as small as it can be consistently with the work done.



Two Types of Automatic Engines for Electric Lighting.

A New Fuse Plug and Base.

A new type of fuse plug and base, designed in accordance with the suggestions and specifications recommended by the special committee of the Underwriters' National Electrical Association, held last December, has been brought out by the Chicago Fuse Wire and Manufacturing Company, and is known as the Goodman fuse plug and base. The accompanying illustration shows the general appearance of the appliance. It is made from what is claimed to be the finest grade of porcelain, the mountings being of the latest approved type and very substantial. The new device is made in sizes suitable for currents of from 10 to 100 amperes on circuits up to 250 volts. For low-voltage circuits the plug is fused with ordinary fuse wire of the proper capacity. For 250 volts a specially made fuse is used, fitting the same plug and claimed to combine the advantages of the best enclosed fuses, beside being placed in a strong porcelain receptacle. The plug and block for 100 amperes at 250 volts are only six inches in length and two and one-half inches in width. A "tell-tale" button projects through the plug and indicates positively whether or not the fuse has blown. This is a mechanical feature and does not expose the electrically connected parts.

Fuse Plug and Base.

Some Pan-American Exhibits.

THE WARREN ELECTRIC MANUFACTURING COMPANY'S PAN-AMERICAN EXHIBIT.

The Warren Electric Manufacturing Company, of Sandusky, Ohio, has a neat display prominently located near the centre of the Electricity Building. The exhibit consists of one 60-kilowatt inductor alternator and exciter of the latest design, occupying the centre of the space. This machine is built for 2,200 volts and 133 cycles, single phase, at a speed of 800 revolutions per minute. On one side of this is a 45-kilowatt alternator and an eight-kilowatt multipolar exciter. On the other side is a 30-kilowatt alternator which is dissembled. This is the most interesting part of the display, as it shows all the working parts of the machine and demonstrates the extreme simplicity of design and principle for which it is noted. Back of the alternators is shown a line of Warren oil-cooled transformers of 600 watts to 8,750 watts capacity, and also some fine photographs of the double-voltage, direct-connected equipment recently installed in the plant at Urbana, Ill. Mr. Harry S. Williams has charge of the exhibit.

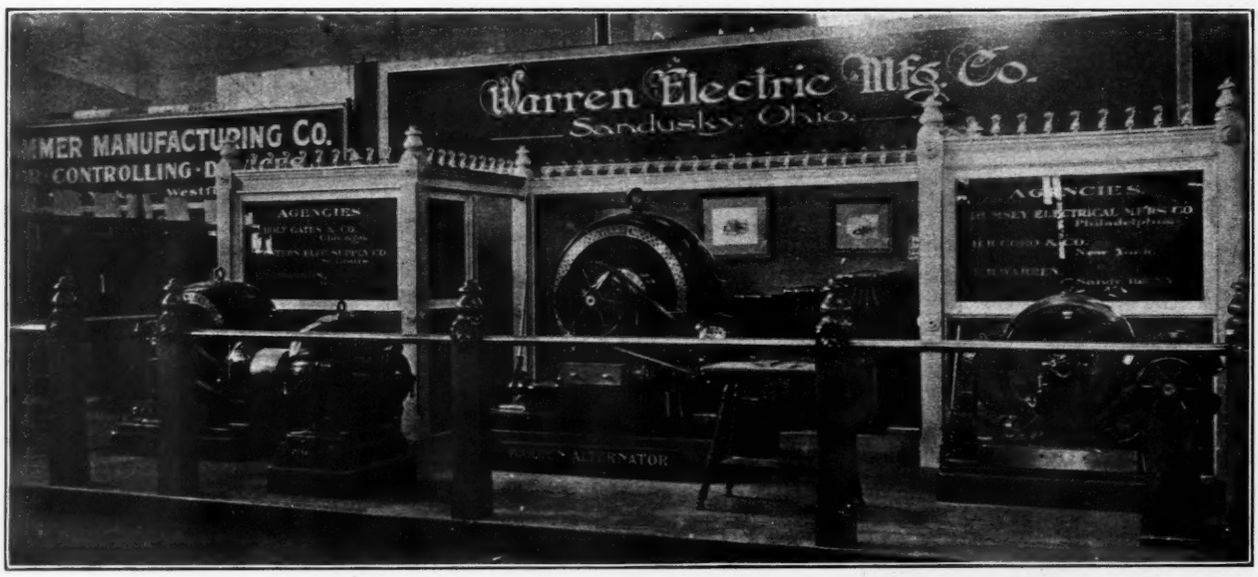


EXHIBIT OF THE WARREN ELECTRIC MANUFACTURING COMPANY AT THE PAN-AMERICAN EXPOSITION.

WESTINGHOUSE EXHIBITS AT THE PAN-AMERICAN EXPOSITION.

The Westinghouse companies have located their very complete exhibits beneath the central dome of the Electricity Building and to the right and left of the main entrance to the Railway Exhibits Building, occupying in all over 6,000 square feet of space.

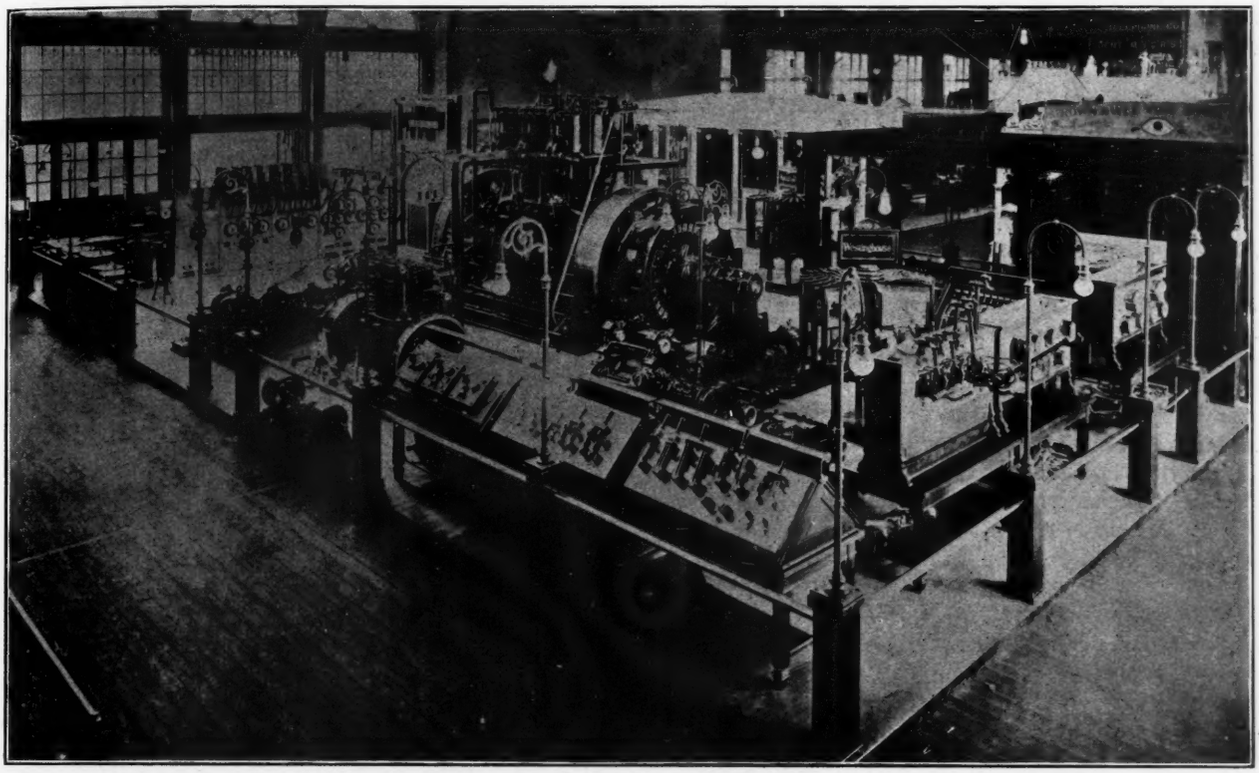
The operation of two gas-engine generating sets is one of the features of greatest interest in the Electricity Building. The large unit consists of a 300-horse-power, three-cylinder, four-cycle gas engine, direct-coupled to a 2,200-volt, two-phase, revolving-field alternator. The smaller unit is a three-cylinder, four-cycle gas-engine, direct-connected to a 125-volt, direct-current generator. The power furnished by the large unit is employed partly in supplying current to 130 Nernst lamps at 220 volts and partly in operating numerous induction motors applied to stationary service.

The small gas-engine generating set is used for exciting the large alternating-current generator, for lighting the switchboard, and for charging the storage sparking outfits for both gas engines. It is used also for operating the motor-generator outfit and for lighting four large electric signs, two of which are placed over the main entrances of the Electricity Building. The switchboard for controlling these generators is equipped with the latest type of measuring instruments, switches, circuit-breakers and auxiliary apparatus. Other standard switchboards for lighting and power service are in place. A 375-kilowatt alternator, revolving-field type, 7,200 alternations, is of particular interest.

Of transformers there are to be seen a complete set of from ¼ to 50 kilowatts, two sizes of manhole type transformers and two 100-kilowatt, self-cooling, oil-insulated transformers. The latter are used to lower the voltage of the 180-kilowatt machine from 2,200 to 110 volts, at which potential they supply the four incandescent signs. These transformers present no radical departure from standard practice.

One of the most novel attractions in the Electricity Building is a high-voltage sign. It consists of two large glass plates covered on the back with metal foil, with lettering in its centre. An alternating pressure having a maximum of 40,000 volts is applied between the foil on the back and the metal letters on the front. As the potential is raised a fringe of violet light appears about the letters, which, gradually increasing in intensity, culminates in a myriad-branched lightning discharge that plays continuously over the surface of the plate and is accompanied by a continuous crash not unlike thunder.

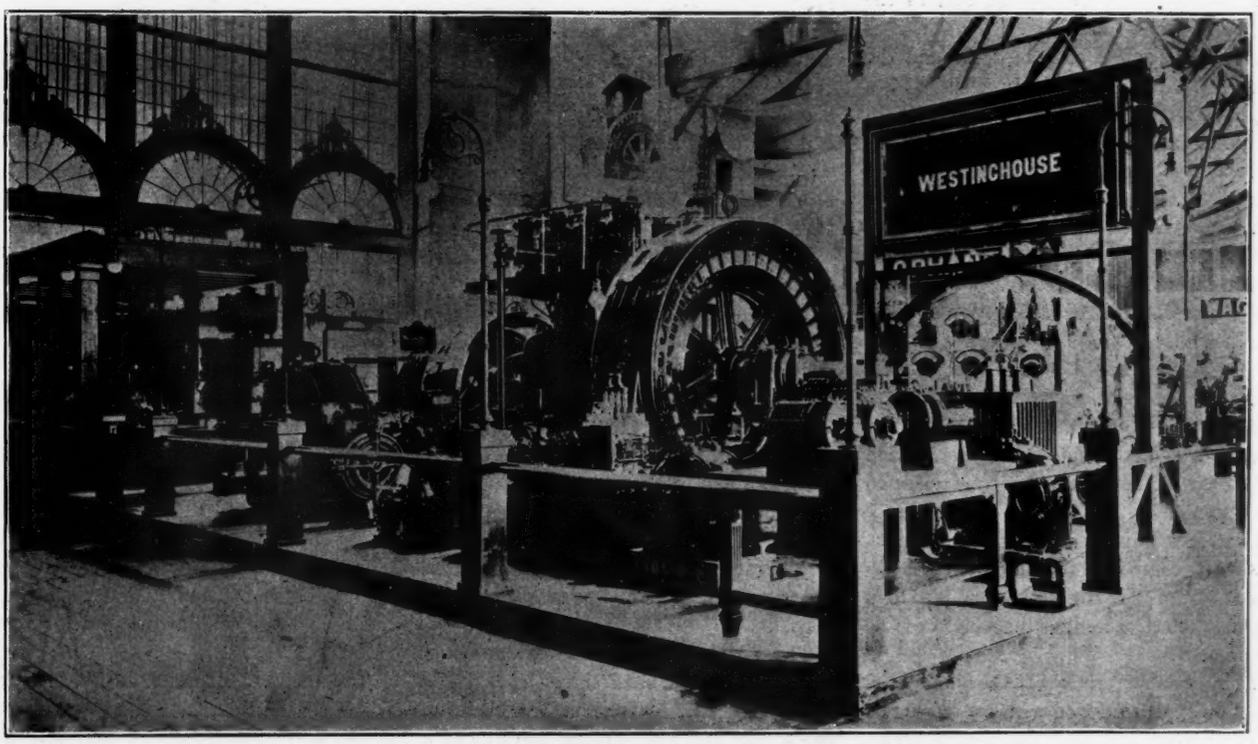
Among the railway motors included in the railway exhibit are a motor for heavy suburban and interurban service, a motor for heavy railway service and a motor for city and suburban service. These motors are split horizontally with their suspension on the lower half of the field. The pole faces are smooth and unbroken, and the armature possesses a ventilated winding. The heavy-service motor is provided with a special cradle suspension from the car axle, thus removing the not inconsiderable weight of the motors from the car truck. This arrangement minimizes the wear of the rails, increases the life of the wheels and, what is most important, makes an easy riding car.



GENERAL VIEW OF THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY'S PAN-AMERICAN EXHIBIT.

There is also a large number of induction motors, adaptable where constant speed is required, and of variable-speed motors. These latter are provided with collector-rings which serve to carry the induced currents of the secondary to an adjustable external resistance, whose operation controls the speed of the motor.

The company also exhibits a complete line of detail apparatus, including motors, lightning arresters, fuse-blocks, switches, circuit-breakers, etc. Included in this comprehensive and interesting exhibit are two large revolving photograph stands containing a great number of pictures



ONE CORNER OF THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY'S PAN-AMERICAN EXHIBIT.

which illustrate engineering work of importance, as well as various electrical and mechanical installations of the several companies.

ELECTRIC POWER BRAKE AND CAR-HEATING APPARATUS.

The necessity of using some sort of power brake to control railway cars operating in urban and interurban service suggested itself immediately that electric traction became practicable. The electric brake and car-heating apparatus shown in full operation at the exhibit more nearly approximates the ideal brake for electric cars than any other appliance heretofore invented. The apparatus consists of two elements, a brake and a car heater. The brake may be installed and used independently of the heater, but the operation of the heater is dependent upon the use of the brake, the produced heat being derived from energy that would otherwise be wasted. This combination of a magnetic track brake with a wheel brake of maximum power produces a braking effect greatly in excess of any heretofore attained. Moreover, cars equipped with the complete apparatus are heated without using the line current, and, therefore, without cost for the electrical energy employed in heating.

This system is shown in operation in two exhibits.

1. A standard single-truck electric car is in constant service on a track extending from the main exhibit in the Railway Exhibits Building to a point east of the building some 250 feet. This car is equipped with the electric brake and car heater complete, and is in charge of a regular street-car motorman, who is in readiness at any time to demonstrate the operation of the system to those interested. When in action powerful magnets force the brake friction shoes upon the rails and set up a strong magnetic attraction between the shoes and the rails, while at the same time the drag or back action of these magnet shoes throws in action a system of levers that apply to the wheels brake shoes of the regular type. The current for exciting the magnet is supplied by the motor, which, through the proper wiring of the controllers, is at this time operated as a generator. With this electric brake system it is impossible to skid the wheels, and any degree of braking power is secured from the slightest effect up to a braking effect exceeding the weight of the equipment.

2. A double truck of the maximum traction type, equipped with two 40-horse-power motors and with the electric brake, is operated on a short section of track by a stationary controller. This equipment shows the enormous braking power of the apparatus and the absolute freedom from skidding of the wheels. The smooth action of this brake is one of its chief features, there being no shock or sudden jolts during its application.

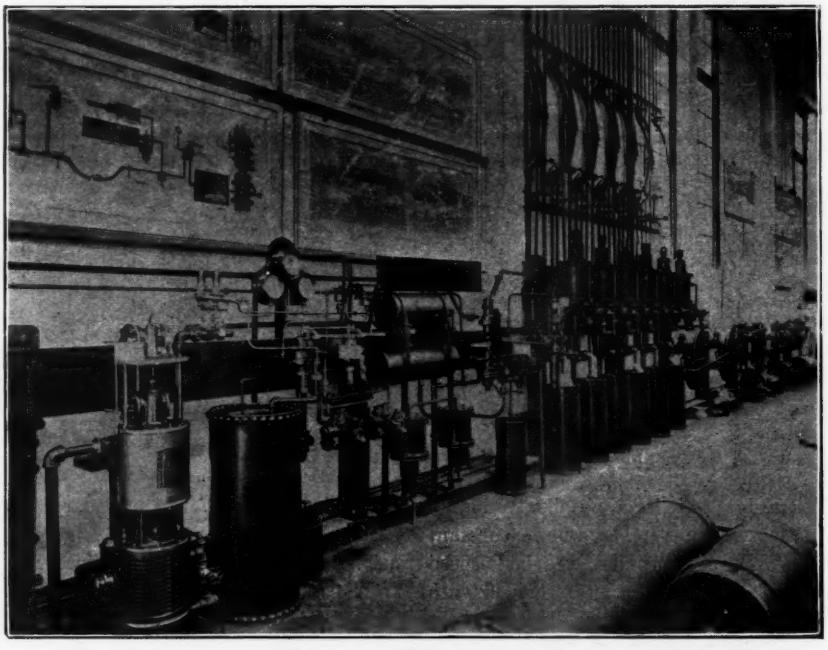
THE EXHIBIT OF THE UNION SWITCH AND SIGNAL COMPANY.

The space occupied by the Union Switch and Signal Company is located just west of the Westinghouse Air Brake Company's exhibit. It contains three of the most important signaling systems owned and manufactured by them—the electropneumatic interlocking and signaling system, the "wireless" system of automatic electric block signaling and the high-speed electric train staff system.

The electropneumatic exhibit is located at the west end of the space and consists of a two-lever section of the latest pattern electropneumatic interlocking machine, a double-arm iron post signal, a dwarf signal and a switch-and-lock movement operating a single switch point complete with detector bar, rocker shaft, electric switch, valve cylinder, etc. These appliances are connected and working. They represent a part of the signaling required for a single-track main-line turnout. Sections of some of the principal parts are also displayed.

The working of the wireless system of automatic electric block signaling is shown on a model track 50 feet long, divided into two blocks and representing one line of a double-track railway with a side track connected at both ends for returning the model engine or car without running against traffic. The switch at the west end is also equipped with a switch instrument and indicators to illustrate the protection provided against misplaced switches or trains from sidings entering on or fouling the main track.

Two of the latest type of electric semaphore signals—a signal and double arm—are operated automatically from the model track and the complete exhibit shows plainly the working of automatic home and distant block signals under the wireless systems. Several of the separate appliances used in this and other systems are on view, including semaphore mechanisms and motors, battery chutes, relay boxes, cranks, wheels, jars, etc. Two of the high-speed electric train staff instruments connected and working show the practicability of operating trains on single track railroads by means of this system and without the use of train orders.



WESTINGHOUSE HIGH-SPEED AIR BRAKES FOR PASSENGER TRAIN.

CROCKER-WHEELER COMPANY'S EXHIBIT AT THE PAN-AMERICAN EXPOSITION.

The exhibit is located in the Electricity Building, in Section O, and occupies a floor space of 20 by 24 feet. The space is devoted to the exhibition of smaller sizes of standard types of machines of this company's manufacture, and no attempt has been made to illustrate special applications.

The list of exhibits includes three-horse-power, seven and one-half-horse-power and 25-horse-power four-pole motors of the semi-enclosed and completely

enclosed types. During the past few years there has been a great demand for this style of motor, which is particularly adapted to cases where great compactness is required, and in locations where it is necessary to protect the motor from exposure to the weather or injurious dust particles.

The chief features of their construction are as follows: A magnet frame, consisting of cast-iron ring having inwardly projecting steel poles. The end faces of this ring are finished, and have bolted to them annular castings which carry the bearings and are cast with four large openings which allow for the circulation of air in the semi-enclosed machines and outer ends on cast-iron flanges. The armature coils are carefully insulated and varnished before being placed in position on the armature cores. The coils are all continuous, and without joints except at commutator connections.

In the construction of the commutator only the best rolled copper is used, the commutator tails being of flat copper, riveted and soldered to the bars. The commutator support consists of a very substantial cast-iron arbor, insulated from the bars by collars of selected mica. The use of rolled copper insures absolute uniformity of quality in commutator bars, and for this reason has been adopted.

The brush-holders are supported on a zontally. These magnet frames are bolted to cast-iron base carrying the pedestals and bearings. The other construction details are similar to the machines described above.

As an example of the direct-connected engine-type dynamo, there is exhibited a 30-kilowatt, 300-revolution per minute machine, mounted on a temporary foundation. This dynamo has an eight-pole magnet with the characteristic internal flange magnet ring. A special feature of interest in this machine is the rocker ring and brush support; and while the generator on exhibition is of small size, yet it illustrates the style of construction of brush rigging used on all of the engine-

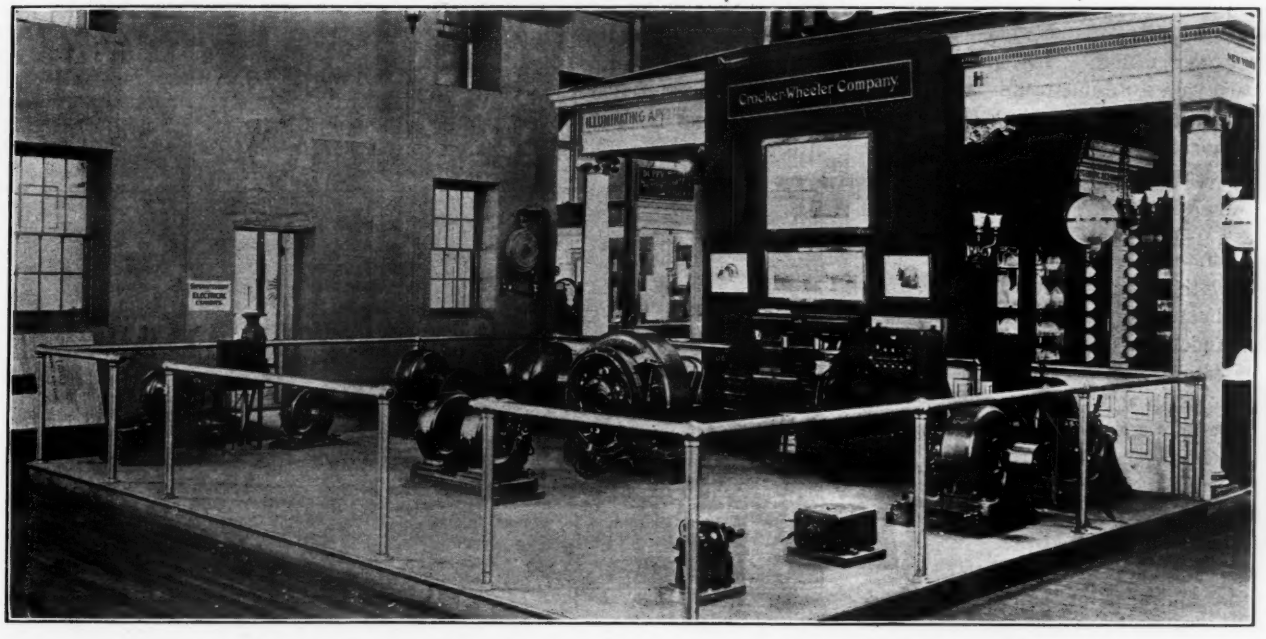


EXHIBIT OF THE CROCKER-WHEELER COMPANY AT THE PAN-AMERICAN EXPOSITION.

also admit of access to the brushes. Where it is desired to more completely enclose the motor, these openings are either covered with tight metal covers or in other cases with metal gauze covers.

The journals are of the ring, self-aligning type, having heavy, solid bronze bushings, and oil wells of ample capacity. One of the advantages of this style of construction is that the end-castings carrying the bearings may be turned either 90 or 180 degrees, thereby enabling the motor to be adjusted for either ceiling or side wall suspension as well as for floor support.

The field coils are wound on removable bobbins, which bobbins are held in place on pole-pieces by removable pole shoes. The armatures are of ironclad cylinder form coil type, the windings being imbedded in slots and supported at their four-arm rocker carried by a projection of the journal box. These brush-holders are of the Crocker-Wheeler parallel type, and are practically the same as those used on the larger machines.

The exhibit also contains a five-horse-power motor and a "size 7½ F" motor-dynamo, consisting of two standard motors direct-connected. These machines show the open-type, small motor, of which the construction is similar to that of the motors described above, with the exception of the magnet frame and bearing support.

To illustrate the large sizes of open type machines there is a 10-horse-power and a 20-horse-power motor. These motors are of standard four-pole, belt-type design. The magnet frames are of cast-iron, having the characteristic internally projecting flanges, and are divided horitype generators up to the largest sizes. The characteristics of this brush rigging are claimed to be very substantial construction. Means for adjusting all brushes simultaneously and also for making permanent adjustments of each brush-holder bracket independently, and compactness.

An incidental advantage of this brush rigging is that in cases where it is necessary to turn off the commutators of such machines, a simple tool manufactured by the company can be bolted on to a brush-holder bracket and the largest commutator turned off without putting the machine out of service for more than four or five hours. This commutator turning arrangement is also so designed as to make it impossible to damage the commutator by catching of the tool. The other details of design of this dynamo are similar in

general to the motor construction already described.

An example of the enclosed-type heavy torque motor, suitable for crane service, is shown. This consists of the smallest size crane motor, known as the size 2½. This machine is of nominal two and one-half horse-power, but capable of working up to a much higher torque, and is commonly used for the trolley travel on smaller sized cranes. Attention is called to the simplicity of construction, compactness, and ease with which armature and brush rigging may be removed.

Another piece of apparatus interesting to manufacturers and users of cranes, elevators, printing-presses and similar machines requiring brakes which act instantly when power is shut off, is one of the magnetic brakes mounted on a five-horse-power motor. This brake is extremely powerful, and readily adjustable over a large range of holding power. It is operated by solenoid, through a system of links so devised that while a powerful effort may be required to pull off the brake shoes a very small force is needed to hold them off. Consequently, no matter how strongly the springs may be set up, the brake shoes will be held off from the brake wheel under any condition of motor load. This feature is particularly valuable in crane work, where the brake solenoid is connected in series with a series motor and where the load on the motor will vary from merely the friction load of the crane to a load corresponding to the maximum weight lifted.

The exhibit also contains several styles of drum controllers of the reversing type, also controllers having an ingenious device for securing quick break and for preventing the drum being left standing between contact points. Other exhibits comprise a knife-blade type of starter suitable for very large motors, with automatic devices, and there is also shown a one-half-horse-power, two-pole motor, illustrating the smaller sizes of this form of machine.

THE LANE & BODLEY COMPANY'S PAN-AMERICAN EXHIBIT.

The Lane & Bodley Company, of Cincinnati, has on exhibition at the Pan-American, at Buffalo, a line of steam engines. The loss of its patterns by fire recently made it necessary to complete a new line of Corliss engine patterns. This opportunity was taken to design an engine embodying all of the improvements which many years in the steam engine business showed to be of value.

The requirements which the engine has been designed to fill are that it shall stand 150 pounds steam pressure, that the ports shall have ample area for a piston speed of 750 feet per minute and that, in case of necessity, the valve gear and other parts of the engine shall work quietly and easily at 125 revolutions per minute.

The engine is of pleasing outline, all ribs and sharp corners having been omitted. The frame is of the heavy-duty type, having a bearing on the foundation for the full length and width. The guides are bored to a large radius, the main bearing is made in four sections; the wedges being forced downward from the top, permit of the removal of the quarter boxes after removing the cap. The bottom shell can be removed by revolving on the shaft, after raising the shaft less than half an inch, thus making it a very easy operation to inspect this important detail of the engine, and obviating the necessity of removing the eccentrics or governor pulley to withdraw wedges from the side.

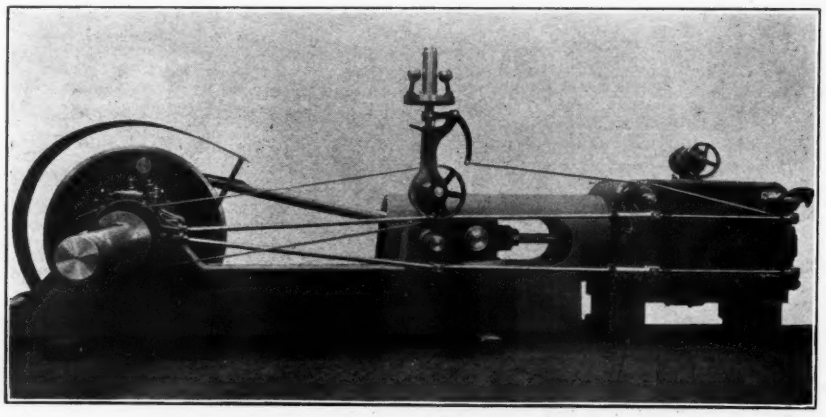
All oil-drips from the guides, cross-head, main bearing, crank pin and eccentrics are collected and carried into a cast-iron drip pan under the crank, from where they can be drained and filtered, if desired. The outer bearing is of the floor-stand type, and the bearing proper is made in four sections, the same as the main bearing. The cross-head shoes are removable without disconnecting the connecting rod. The connecting rod is of the usual solid-end type, with babbitted crank-pin boxes and bronze cross-head pin boxes. The cylinder has round corners, which this company was first to introduce, with sheet-metal lagging and polished angle corners.

In the valve gear a most striking innovation has been made. The steam and exhaust valves are each operated by a separate eccentric, the eccentric rods connecting to rocker arms, and from there two parallel rods are attached directly to the steam and exhaust bell cranks. These rods are all light, and the travel being only three and one-half inches, the vibration and jar due to excessive inertia strains commonly seen in ordinary Corliss valve gear at high speeds are entirely obviated.

The valves are double ported and of small diameter. The steam lever which operates the steam valve is keyed onto the valve stem between the front of the bonnet and the stuffing box, thus supporting it on both sides of the point where the work is applied, and reducing to a minimum the chance of a broken valve stem.

The dash pots are of an approved type of vacuum pots, consisting of a single cylinder and plunger. The rod is attached to the latter by a ball joint, and the location of the dash pots, close up under the steam bonnets, makes the rods short and light, places the dash pots in a convenient place for inspection and adjustment and removes them from the dust and dirt by which they are usually surrounded when placed on the floor. The lubrication of the plunger is effected by applying oil to the plunger in a groove at the top of the cylinder. The tendency of the vacuum is to draw the oil into the cylinder instead of its being blown out by the air of the compression chamber, as was the case with the old type.

The governor is of the well-known Hartnell type, running 200 revolutions per minute, this speed making it very sensitive to slight variations in load.



LANE & BODLEY ENGINE AT THE PAN-AMERICAN EXPOSITION.

New Fuel Used in Germany.

United States Consul Hughes, of Coburg, Germany, reports that large quantities of "masut" (an oily product of German brown coal tar) are being used for heating and steam-producing purposes. Its advantages over coal are given as follows: (1) The heat-producing qualities of "masut" are said to be one-fourth greater than those of coal; (2) the oil is easier to handle, it being only necessary to open a valve; (3) very little smoke comes from the use of the "masut"; (4) steam can be produced and full power reached in less time. The coast-defense vessels of the German Navy are fitted for the use of this oil. Some of the battleships and cruisers are also so arranged that they can use both coal and "masut."

Current Electrical News

COMMERCIAL NEWS

DOMESTIC AND EXPORT

The New England Telephone and Telegraph Company, of Boston, is installing a new switchboard in its main operating room, which is of the most modern type, and by means of which the company hopes to be able to give its patrons the most efficient service possible.

After numerous experiments with various telephone systems the German postal authorities have selected the American automatic telephone system as superior to all others, and have decided to establish it permanently as a part of the postal service. The instruments will be made at the factory of the Strowger Automatic Telephone Company, in Chicago.

The Jeffrey Manufacturing Company, of Columbus, Ohio, has secured a contract through its English agents, Russell & Duncan, Limited, of London, for the shipment of an electric coal-cutting plant, which is to be utilized at the Serampore Colliery of the East Indian Railway Company. The value of the contract is between $35,000 and $50,000.

The officers and directors of the Illinois Manufacturers' Association have decided to bring legal proceedings at once against the Chicago Telephone Company to compel it to reduce its maximum charge for instruments from $175 to $125 a year. This rate was fixed in the franchise under which the company is operating.

The Northern Electric Company, Madison, Wis., has decided to build a $100,000 extension to its plant there. The company has combined with the Stanley Electric Manufacturing Company, of Pittsfield, Mass., and the local plant will be the western factory of the combine. The principal stockholders of the Madison company are former Senator William F. Vilas and Mr. Fox, his brother-in-law.

A new concern to be known as the American Insulating Machine Company has recently been formed to manufacture insulating machinery and supplies. Mr. Thomas S. Reed, who was formerly with the American Electric Works, of Providence, and Mr. Robert W. Withington, of Philadelphia, are interested in the new company. The offices of the company are at New Haven, Ct., and 940 North Third street, Philadelphia.

The Mann & Erie Canal Transportation Company has commenced the installation of an electric system for towing its canal boats. Mr. Warren M. Bicknell, of the Southern Ohio Traction Company, will have charge of the work and will employ 100 teams and several hundred men. It is believed that the application of electricity to the service will make the canal a formidable competitor of the steam railways of southwestern Ohio.

The basis of the effort to acquire the Kensington Electric Company for the Philadelphia Electric Company, as is stated upon good authority, has been by purchase of stock. Most of the minority stock is now held by the Philadelphia Electric people, but the leading interests have agreed not to withdraw or sell. Thinking that sooner or later there will be a break in the line, the policy of the Philadelphia Electric people is to wait.

The president of the Snoqualmie Falls Power Company, Charles H. Baker, of Washington, announces that the company will spend approximately $350,000 in improvements. It will build a new power chamber in the solid rock just north of the present chamber. To supply this a new steel pipe will be constructed in the shaft, carrying the water from the river to the new waterwheels. Three generators of 4,000 horsepower each will be installed in the new chamber.

Referring to the prospects for trade in South Africa, Colonel Stowe, the United States Consul-General, calls attention to the fact that the losses by war must be replaced. They cover nearly everything which enters into life. Among them are machinery of all kinds for farms and mines, apparatus for lighting cities and houses, equipment of railways and cold storage plants, telephones, telegraphs, bridges, etc. Colonel Stowe points out that $5,000,000 of mining machinery has recently been imported from the United States.

The electric light plant in the city of Manila is being remodeled and enlarged by the addition of condensers, pumps, heater apparatus and a cooling tower. The new plant will have a capacity of 2,500 horse-power. Contracts for this equipment have been placed by Bagnall & Hilles, an American electrical engineering and contracting firm with offices in Yokohoma, Singapore and Manila. The Wheeler Condenser and Engineering Company, of New York, will furnish the new apparatus, and a large steel stack will be made by the Philadelphia Engineering Works, of Philadelphia.

It is said that Mr. John B. McDonald, who has the contract for building, equipping and operating the underground railway in New York, will make an effort to have a section of the line finished considerably in advance, in order that experiments may be made with the various systems of traction before adopting one for the entire line. In order to make these experiments it is said that Mr. McDonald may purchase a piece of property near the part of the line to be used for experimental purposes, on which he will erect a power-house to furnish the power needed in these experiments.

One of the largest electrical deals ever consummated in the South was the consolidation of the Carrollton Railroad Company, the Edison Electric Company and the Merchants' Electric Company, all of New Orleans, on July 10. The capitalization of the new concern will be $7,500,000, of which $5,000,000 will be preferred stock and $2,500,000 common stock. J. K. Newman, banker and financier of New Orleans, will be president of the new company. With the exception of the power-houses of the New Orleans street car companies this deal brings under one management the entire electrical power of the city.

It is reported that several prominent capitalists have become interested in the million-dollar company which Mr. Edison has organized for the manufacture of electric storage batteries under the new patents granted the inventor. Among those who are said to be interested are President Schwab and Director Gary, of the United States Steel Corporation; Samuel R. Callaway and H. McKay Twombly. A mill has been purchased near Orange, N. J. Only $300,000 of the $1,000,000 stock has been isssued to any one outside of Mr. Edison and his immediate friends, and this was given as a bonus to subscribers for the $500,000 bonds.

Charles T. Yerkes has complied with the requirements of the Companies' Act and filed articles of incorporation of the Metropolitan District Electric Traction Company, with the names of stockholders, at Somerset House, London. Of the capital stock of the company, which amounts to $5,000,000, Mr. Yerkes holds $1,680,000. Mr. Yerkes is chairman of the concern; Mr. J. Wilcox Brown, president of the Maryland Trust Company, is secretary, and the following American names appear on the list of directors: John H. Parsons, of Philadelphia; Brown Brothers & Company, and H. H. Rogers, of New York; T. Jefferson Coolidge and Frederick Ayers, of Boston, and John H. Mitchell, of Chicago.

A syndicate owning what is known as the Dodge water power in Sheldon, Vt., has purchased a controlling interest in the St. Albans Electric Light and Power Company, the company has been reorganized, and the result will be eventually that the power plant in St. Albans will be abandoned and that electricity for lighting and power will be brought in from Sheldon. The syndicate is composed of John F. Kelley and C. C. Chesney, of the Stanley Electric Manufacturing Company, of Pittsfield, Mass.; W. F. Fairchild, of New York; I. C. Blandey and H. C. Gray, of Greenwich, N. Y. The officers of the reorganized St. Albans Electric Light and Power Company are: President, John F. Kelley; vice-president, M. Magiff; treasurer, H. C. Gray.

In Shasta County, Cal., the Shasta Electric Light and Power Company has preempted 50,000 inches of the water of the McCloud River at a point 14 miles above the point where that stream joins the Pit, and an electric power plant of 12,000 horsepower will be developed. Surveys have already been made, and the plant is being manufactured for the works. The power obtained wil be used to operate a broad-gauge electric railway connecting the famous Bully Hill mines with the Southern Pacific Railway line. It is said that the Crocker and Fair estates are backing the enterprise, which is capitalized for $2,500,000. It is proposed to have the works in operation by November 1, and the total cost of construction will approximate $1,000,000.

It will be good news to American electrical manufacturers to learn that the Scotch trade in electric motors for electric power stations and coal mines is growing more and more important commercially each year. The market which is being opened up is sound and permanent, subject only to the ordinary fluctuations of trade. There is a growing preference for American electrical machinery, and, as long as prices and quality continue satisfactory, the trade built upon this foundation is likely to endure. It should be kept in mind by electrical manufacturers who intend to market goods in Scotland that it involves a clear demonstration of its merits to sell a Scotchman anything with which he is not familiar.

It has been officially announced that the Everett-Moore Syndicate will merge its electric railway interests. The capital will be about $150,000,000. This great system of electric roads represents the first great electric railway system of the world, and the success which has attended the consolidation of this gigantic syndicate seems prophetic of the future of electric railways. Over 25 different city and interurban lines have been acquired, which include the city lines in Port Huron, Mt. Clemens and Detroit, Mich., and in Sandusky, Lorain, Cleveland and Akron, Ohio, and the interurban lines connecting them. The complete mileage in operation is 1,215, while over 400 miles of additional track are under construction. The total earnings of this huge system already amount to over $10,000,000 per year.

ELECTRICAL SECURITIES

The feature of the week past, in so far as a somewhat dull week in midsummer may be said to have a feature, is growing confidence in the general industrial and business outlook of the United States. Apprehension, which had been so widely aroused on account of the unprecedented heat and dry weather in the corn-producing sections, has largely died away, and the belief is growing that the damage was neither so widespread nor so great as was at first generally believed. At any rate copious rains have fallen and there seems a chance that the district involved will produce crops of money value not greatly inferior to the usual annual standard. At the same time the various conflicts of labor organizations and their employers have exhibited signs of early settlement, the strikes of the machinists and mine-firemen having been abandoned, while that of the steel workers is believed to be in process of amicable settlement. Fears which had been felt that these contentions would spread to other branches of industry have been dismissed, and at no time has the outlook been better than it is at present. Despite the heat of the summer general business has been large, while the prospect for fall trade in every department is exceedingly encouraging. Below is given a summary of the markets for electrical securities in the various financial centres of the country:

ELECTRICAL SECURITIES FOR WEEK ENDING JULY 27.

New York:	Highest.	Lowest.	Closing.
B'klyn R. T	77½	75¼	76¾
Con. Gas.	221	213	220
Gen. Elec.	259	25 7/8	255
Man. El.	119½	116½	119
Met. St. Ry.	169	165¼	169
Third Ave. R. R.	...	.	123
Kings County Electric	...	...	205
N. Y. & N. J. Tel. Co.	...	...	175
Telep., Tel & Cable Co.	...	...	6

A general meeting of the General Electric Company will be held week after next when it is expected that the new stock will be issued.

President Greatsinger, of the Brooklyn Rapid Transit Company, is quoted as saying that the losses of fares to that company during the excitement over the Brooklyn Bridge accident amounted to $15,000 a day.

President Thomas, of the Telephone, Telegraph and Cable Company, says that plans have been made to connect Boston and New York, Albany and Philadelphia, and intermediate cities by the company's own wires. This will demand $9,000,000 the first year and $5,000,000 the second.

Westinghouse Electric and Manufacturing Company has declared a regular quarterly dividend of 1¾ per cent on assenting stock payable August 15, books closing on August 6.

Unexpected delays have developed in the completion of the new motor cars and their electrical equipment for the Manhattan Elevated Company, and it is probable that the new rolling stock will not be received before December. The installation of the third rail is proceeding rapidly, and it is believed that the Second avenue line will be the scene of a trial trip of electric cars in about three weeks.

Boston, July 27:	Closing.
Am. Tel. and Tel.	162½
Erie Tel.	50
New Eng. Tel.	135
Mass Elec. pf.	94
Westing. Mfg. pf	79½
Edison Elec	260

The Boston Stock Exchange has given notice that the stock of the Boston Electric Light Company has been dropped from the list, and that it is admitted for quotation on the unlisted issued certificates and deposit for this stock issued by the Old Colony Trust Company.

The securities of the Minneapolis, Minn., General Electric Company will soon be listed on the Boston exchange. There are $1,600,000 bonds 5's and 6's, $750,000 6 per cent preferred stock and $1,500,000 common stock. This company has a monopoly of electric lighting in Minneapolis.

The New England Telephone and Telegraph Company has declared a regular quarterly dividend of 1½ per cent, payable August 15. The transfer books remain closed from August 1 to August 14 inclusive.

Philadelphia, July 27:	Closing.
Elec. Co. of A.	6⅝
Philadelphia Elec	5¾
Union Traction	27
United G. I. Co.	116
Elec. Sto. Bat. c.	75
Elec. Sto. Bat. pf.	75

The Electric Company of America has purchased two new plants, one in New York state and one in Ohio, and a considerable part of the company's $900,000 uninvested capital will now be reinvested on account of the purchase of these plants.

Chicago, July 27:	Closing.
Chicago Edison Light	180
Central Union Telephone	36
Chicago Telephone	275
Un. Trac	20
Un. Trac. pf.	21
Metropolitan El.	89

President John M. Roach, of the Union Traction Company, in his annual report says the operation of the Northwestern Elevated road through the company's territory results in a direct loss in traffic of from $1,500 to $2,000 a day. After paying the first quarterly dividend and improving the efficiency and standard of the company's equipment a surplus of $12,650 is on hand.

ELECTRIC LIGHTING

A $2,000 electric light plant will be built by the college authorities at Maryville, Tenn.

J. B. Wampler is at the head of a scheme to construct a $50,000 electric light plant at McKeesport, Pa.

At Unionville, Ct., work is expected to begin on a new electric light plant during the coming week.

A new electric light plant is being built at Tipton, Ind. Excavations for the foundation began last week.

An electric plant will be established by the United States Government at Fort Williams, Me. Major Roessler has charge of the work.

At Cleveland, Ohio, M. A. Bradley will construct a new power block which will consist of seven stories and have 99 feet front by 165 depth.

A new electric light plant will be constructed at Woodstock, Ontario. Bids will be asked for by Superintendent J. G. Archibald in the course of a few days.

The majority of the select and common branches of McKeesport, Pa., councils have announced themselves in favor of an electric light plant to cost the city $150,000.

The city of Dunkirk, N. Y., has granted a franchise to Adelbert W. Cummings to install a plant to supply heat and light and electric power. A $20,000 plant will be built at once.

Connection by telephone has been made between Bristol and Quakertown, Pa., by the Standard Telephone Company, which is extending its lines throughout Bucks County.

The Monroe, N. J., township committee has passed an ordinance giving the Wenonah, Glassboro & Clayton Electric Light Company the right to erect poles and string wires in Williamstown, N. J.

The city council of Bowling Green, Ohio, has awarded the electric lighting contract for 10 years to the Bowling Green Electric Light and Power Company, which is represented by E. H. McKnight.

Plans have been drawn for a $150,000 power-house and plant, to be erected in Kearney, N. J., by the New Jersey Light and Power Company, which was recently incorporated in that state.

The Butler Light, Heat and Motor Company, of Butler, Pa., will change the location of its power plant. A site has been purchased at a cost of $35,000, and a $20,000 building will be immediately erected.

Work on No. 2 power-house of the Ottawa, Ontario, Electric Company will soon be completed. The machinery, which has been purchased from the Westinghouse company, of Pittsburgh, Pa., will be installed about September 1.

The Sandusky Gas and Electric Company has secured a contract for lighting the city of Sandusky, Ohio. The company will begin at once to make improvements in its plant, new machinery will be installed in all departments and the line will practically be rebuilt.

The Grand Island Gas Company, of Grand Island, Neb., will have its new electric light department in operation after the first of August. Grand Island will then have two electric light plants in active operation, and a third plant for the exclusive use of the city is contemplated.

At a meeting of the board of trustees of the Pythian Home, Springfield, Ohio, very elaborate plans were made for an addition to the present building and other improvements. Among them is the building of an electric light plant to supply all the buildings of the institution.

In the recent report filed with the New York State Board of Charities, in regard to the condition of the Kings County Almshouse, it was shown that a saving of $19,000 a year would result from the establishing of a private electric light and power plant in the almshouse.

The city of Owensboro, Ky., has employed H. C. Harrington to complete the new electric light plant, for which a contract was recently given to Westinghouse, Church, Kerr & Company. The city refuses to pay the company a large balance due it because of an adverse report rendered by Mr. Harrington.

The People's Light and Power Company has filed articles of incorporation in the office of the County Clerk at Newark, N. J. The principal office of the company will be at 161 Washington street in that city. The authorized capital stock is $1,500,000, divided into 15,000 shares, the par value of which is $100 each.

AUTOMOBILE NOTES

At a special meeting of the Automobile Club of America, held July 17, in New York city, the subject of the affiliation with the various automobile clubs throughout the United States was discussed, and a committee of seven appointed to formulate a plan for such affiliation and submit it to the board of governors, or to the club, as they might deem best, said committee to consist of the president, first vice-president, the three members of the law committee and two other members to be named by the chairman.

The rapid driving of automobiles through the streets of Newport, R. I., has caused the authorities to adopt measures to limit the speed of these vehicles. Accidents have been numerous of late, and many complaints have been made to the police authorities to adopt some measures which will tend to curtail them. The police have therefore been instructed to inforce the present law against fast driving, which has up to this time been a dead letter on the city statute books. The fine is only $10, but it is believed that when the penalty is inflicted two or three times it will operate as a cure.

ELECTRIC RAILWAYS

A trolley line is proposed to connect the towns of Hornellsville and Howard, N. Y.

The survey of a new electric line from Battle Creek to Coldwater, Mich., is being made.

The Twin City Rapid Transit Company has arranged to connect St. Paul and White Bear, Minn., by trolley line.

A plan is on foot to connect East St. Louis with Lebanon, Ill., by a trolley line which will use the old B. & O. track.

Two corps of engineers began work last week on the proposed routes of the Pittsburgh rapid transit system.

Engineers have begun work on an electric line to be built from Fredericksburg, Va., to the Rappahannock County line.

Cars are now running on the new line of the Millville Traction Company, of New Jersey, between Millville and Vineland.

A Chicago syndicate has been granted a franchise at Valparaiso, Ind., to operate a street railway in the city and county.

Surveys for the Lee County electric road from Steward to Dixon, Ill., will soon be completed. Richard C. Canterbury has charge of the surveying.

It is proposed to build an electric railway line from Paducah, Ky., to the town of Wickliffe. The citizens of Ballard County are interested in the scheme.

The Clyde Electric Power Company has applied to the board of trustees of Clyde, N. Y., for permission to construct and operate an electric street railway.

The authorities of the Grove City College, of Grove City, Pa., have decided to erect a power-house on the college property for lighting of the buildings and grounds with electricity.

J. L. Blackwell & Company, of Baltimore, have been awarded the contracts for building the Philadelphia & Paoli, Westchester & Southern, and Coatsville & Downington trolley lines.

The Schenectady, N. Y., Railway Company proposes to extend its lines in a half dozen different directions, giving better service to Bellevue, Athens Junction, Mount Pleasant and South Schenectady.

The Kansas City-Leavensworth Railway Company has decided upon its route from Kansas City, Kas., to Kansas City, Mo., and a petition for a franchise will be presented at once to the council of the latter city.

Mr. P. L. Spooner, of Madison, Wis., has filed an application with the city council of Stoughton to construct a street railway line through that town, connecting Madison, Evansville, Janesville and Oconomowoc.

At Munising, Mich., surveyors are at work on the road for the east branch of the Munising railway. It is the intention of the company to complete at least 15 miles of the line before winter sets in.

The Consolidated Light and Power Company, of Birmingham, Ala., has announced that it will within one month's time begin work on the extension of its electric lines from Birmingham to Powderly, through the city of Bessemer.

It is said that the electric road projected by S. E. Hayes, of Standish, Mich., to extend from Standish to northern towns in Michigan, is now assured, enough capital having been subscribed to push the project to a successful conclusion.

A syndicate of Philadelphia capitalists has secured an option on 800 acres of land three miles north of Wheeling, W. Va., for $240,000. The property will be laid out in lots, and an electric car line will be built to connect it with the city of Wheeling.

Preparations have been made for the opening of headquarters in Muncie by S. M. Hexter, president of the company which is to build the new line from Muncie to Fort Wayne, Ind. S. J. Schlesinger, of Cleveland, is to have charge of the preliminary work in Muncie.

At Galveston, Tex., work has commenced on the new power-house for the street railway company, which is to cost $165,000. It is located on the site of the one which was destroyed by the recent Galveston storm. The new power-house will be the finest in the South.

The council of Collingswood, N. J., has passed the ordinance permitting the Camden & Suburban Railway Company to extend its line through Collingswood on its proposed extension to Haddon Heights. The ordinance compels the company to have the tracks laid and in operation within one year.

The West Electric Light and Power Company, of Naticoke, Pa., has been given a franchise by the borough council to erect poles in the borough for the furnishing of light to the citizens of Nanticoke. The company will be ready to furnish light by the first of the coming year.

The Schenectady Railway Company's line from Schenectady to Albany is almost completed. It will be double tracked throughout and will be equipped with the most expensive cars used on any similar road in this country. A schedule of 45 minutes is promised between the two cities—a distance of 17 miles.

The Union Railway Company has secured a franchise from the Mayor of New York city to build a double track connecting its various lines already in operation in the Borough of Bronx. The franchise allows the company to use the overhead system, or any other power which may be lawfully employed by the same.

At a meeting of the stockholders of the Sharon Street Railway Company, held in Sharon, Pa., on July 15, it was decided to issue $500,000 worth of bonds for the construction of a new trolley line from Sharon to New Castle. The line will be 21 miles in length. M. A. Devitt, of Chicago, H. W. Whipple and George F. Penhale, of New York, are the promoters.

A franchise has been asked of the police jury of Ascension Parish, La., for the construction of an electric line from Houma, *via* Thibodaux, to Donaldson. A few planters along the proposed route are opposing the scheme on the grounds that the negro laborers in the fields would be distracted from their work by the passing cars, thereby causing a loss to the planters.

The Hartford & Springfield Street Railway Company has been organized by Boston capitalists and will connect these two cities by trolley. The road will be 25 miles in length, and all equipments will be of the very latest type adapted to fast service. The capitalization of the company will be $375,000 in five per cent 20-year bonds and $375,000 stock. All securities have been placed.

By the action of the select council of Norfolk, Va., the Bay Shore Terminal Company has secured a 30-year franchise for a street railway through every ward of that city, with perhaps one exception. There were two other competitors for this franchise, both said to be backed by Pennsylvania capital. One of these companies made a bid of $45,000, but the bid was turned down, and the franchise granted the Terminal company for $30,000.

NEW INCORPORATIONS

CLEVELAND, OHIO—Consolidated Electric Construction Company. $25,000.

PITTSBURGH, PA.—City Electric Company. $1,000. To supply light, heat and power.

BALTIMORE, MD. — Union Telephone Company. $3,000. Incorporator: Benjamin T. Jordan & Company.

SAN ANGELO, TEX.—San Angelo Telephone Company. $80,000. Incorporators: J. Y. Pust, J. W. Sims and L. Pust.

PLEASANT PLAINS, ILL. — Boynton Telephone Company. $2,500. Incorporators: E. D. Boynton, J. M. Howard, O. E. Ferry.

MAGNOLIA, ILL.—Magnolia Mutual Telephone Company. $2,500. Incorporators: Perry Dakin, E. E. Barbour and John Davidson.

DUBUQUE, IOWA—Dubuque, Vinton & Southwestern Railway. $100,000. M. H. Day, F. D. Stout, D. D. Myers and others are interested.

CHARLESTOWN, ILL.—The Consumers' Gas, Fuel and Electric Company. $5,000. Incorporators: William P. Coffey, Joseph Cluke and Charles Newman.

BRUCE, CHIPPEWA COUNTY, WIS.—Chippewa Valley Telephone Company. $10,000. Incorporators: O. E. Pederson, A. L. Arpin, A. Hein and 10 others.

CONCORDIA, KAS.—Concordia Telephone and Telegraph Company. $20,000. Directors: George G. Hill, Washington; William Lutt and F. W. Daigherty, Concordia.

NEWARK, N. J.—National Electric Light, Heat and Power Company. $200,000. Incorporators: John E. Helm and Frederick C. Fisher, of Newark, and William Pelzer, of New York.

COLUMBUS, OHIO—Marysville, Delaware, Sunbury & Mt. Vernon Railway Company. $10,000. Incorporators: B. L. McElroy, F. D. Simons, T. A. Simons, C. E. Miles and J. W. Holcomb.

DES MOINES, IOWA—Western Electrical Construction and Fire Alarm Company. $50,000. Name changed to Western Fire Alarm Company. Incorporators: J. R. Windsor, Edward Kunkle, W. M. Houston, J. H. Lyman and H. E. Jones.

STEWARD, ILL.— Northern Illinois Electric Railway Company. $700,000. Incorporators and board of directors: E. L. Titus, I. R. Titus, of Steward; S. D. Frost, of Amber; Sherman L. Shaw, of Lee Centre, and G. H. T. Shaw, of Dixon, Ill.

PHILLIPSBURG, N. J.—Reflect Incandescent Lamp Company. $300,000. Incorporators: J. W. Cowell, Howard P. Kinsey, Albert R. Dunn, R. H. Leach, Frank C. Miller, Theodore F. King, James R. Searfass, Clinton Hilliard, Edwin C. Hess.

ALBANY, N. Y.—Bolivar Telephone Company. Capital not named. President, E. J. Wilson; vice-president, H. L. Zimmerman; secretary, W. L. Nichols; treasurer, John P. Herrick; directors, E. J. Wilson, H. L. Zimmerman, F. L. Coars, W. T. Bliss, John P. Herrick, W. L. Nichols, Louis Seibert.

ALBANY, N. Y.—Monroe County Electric Belt Line Company. $250,000. Directors: Percy R. McPhail, Ira M. Luddington, Geo. W. Aldridge and Merton E. Lewis, of Rochester; Andrew H. Bawn, of Penfield; Walter A. Parce and D. C. Becker, of Fairport; W. H. Rowerdick, of Brighton, and Fred W. Guernsey, of Pittsford.

TELEPHONE AND TELEGRAPH

The Southwestern Telegraph and Telephone Company has completed its telephone exchange at Hempstead, Tex.

A recently chartered company is preparing to construct a telephone line from Charleston to Ozark, Ark.

The long-distance telephone company of Staunton, Va., is building a line which will connect Richmond and Newport News.

The farmers in the vicinity of Frazeysburg, Ohio, are considering plans to construct an independent telephone system.

The Illinois Telephone Company, of Chicago, has secured $5,000,000 with which it will continue the construction of the system.

The Overton County Telephone Company has filed an amendment to its charter at Nashville, Tenn., increasing its capital stock to $20,000.

A company has been formed at Jersey Shore, Pa., for the purpose of building a telephone line from that city to Wellsboro, in Tioga County, Pa.

The Cumberland Telephone Company is installing an exchange at Lenoir City, Tenn. It is also surveying a proposed route from Kerryville, by way of Buckeye, Elk Valley and Newcomb, to Jellico.

The Ontario Telephone Company is seeking a franchise for constructing a line and installing instruments in Toronto. It offers business 'phones at $36, and private 'phones at $24 per annum, and agrees to provide a forfeiture bond of $50,000.

The Elberton Telephone Exchange to Elberton, Ga., has been purchased by the Bell Telephone Company, at a cost of $6,000. Long-distance 'phones will be installed, which will place Elberton in connection with Atlanta and the other cities of the state.

The Interstate Telephone Company of New Jersey will ask a franchise of the authorities of Jersey City for wiring the city. The company has an authorized capital of $10,000,000, and is said to be willing to pay for the franchise.

It is reported that the Jasper County, Iowa, Telephone Company has purchased the old Iowa exchange in Colfax and will begin at once to make important improvements in the telephone service in that city. Both long-distance and local service will be maintained.

Telephone consolidation in Maryland seems to be increasing at a remarkably rapid rate, as is shown by the recent merging under one management of the Western Maryland Telephone Company. Carroll County; Cumberland Valley Te'ephone Company; Maryland Telephone Company, of Hagerstown, together with the Gettysburg, Hanover and Adams County Telephone companies of Pennsylvania.

The annual meeting of the Standard Telephone and Electric Company was recently held at Madison, Wis. The capital stock of the company was fixed at $300,000. Mr. Thomas H. Gill, attorney for the Wisconsin Central Railway, of Milwaukee, Wis., was elected president; A. L. Hutchinson, of Weyauwega, Wis., vice-president and general manager, and E. W. Batchelder, of Madison, secretary and treasurer.

The Seaboard Telegraph and Telephone Company, of New York, proposes, in connection with the Southside Telephone Company, to extend the lines of the latter company through all parts of Nassau and Suffolk counties, so as to reach every village. It is putting its lines in Queens County in repair, it is said, in order to connect its Long Island system with independent telephone lines in Brooklyn and other parts of the country.

PERSONAL MENTION

MR. W. S. ROWE, of Cincinnati, Ohio, has been elected a member of the board of directors of the Bullock Manufacturing Company.

MR. LAMAR LYNDON, electrical engineer, whose office was formerly at 95 Liberty street, has removed to the Park Row Building, New York city.

MR. AND MRS. EUGENE MUNSELL, of New York, sailed for Europe last week. Mr. Munsell is president of Eugene Munsell & Company, the mica house.

MR. JOHN S. SPEER, general manager of the Speer Carbon Company, St. Marys, Pa., was in New York and eastern cities during the past week. This company is contemplating enlarging its factory at St. Marys and materially increasing its output.

MR. GEORGE R. MATTHIEU, president of the Association of Electrical Contractors of Pittsburgh and Western Pennsylvania, was elected treasurer of the Association of Electrical Contractors of the United States at the recent meeting of the latter body at Buffalo, N. Y.

MR. D. C. CHURCHILL sailed from New York for Bombay, India, on July 20. He goes to establish and develop a system of model trade schools at Ahmednagar, a town 175 miles inland from Bombay. Mr. Churchill was graduated from the Massachusetts School of Technology in 1899, and since that time he has been connected with the Westinghouse company in Pittsburgh.

INDUSTRIAL ITEMS

THE NEW YORK & OHIO COMPANY, Warren, Ohio, is now distributing its calendar for August.

THE ERICSSON TELEPHONE COMPANY, New York, is sending out a very original and handsome series of advertising cards, designed by Samuel Jaros, New York.

THE ELECTRIC APPLIANCE COMPANY, Chicago, has just issued descriptive matter pertaining to its new series and bridging cabinet-type telephones. Circular will be mailed upon application.

THE ELECTRO-DYNAMIC COMPANY, Philadelphia, Pa., is manufacturing a watertight receptacle for incandescent lamps, particularly adapted to marine work, cold storage plants, breweries and other places where moisture is excessive.

THE OSCAR BARNETT FOUNDRY COMPANY, Newark, N. J., is offering a special gray iron casting, both smooth and soft, for electrical work and particularly for motor shells, telephone equipments, arc lamps and other special electrical purposes.

THE PERU ELECTRIC MANUFACTURING COMPANY, Peru, Ind., will be pleased to send its "Red Book" to those requesting its catalogue. This "Red Book" contains illustrations and descriptions of the Peru products, which consist of porcelain electrical specialties.

THE KELLOGG SWITCHBOARD AND SUPPLY COMPANY, Chicago, is distributing, from its Pan-American exhibit in the Electricity Building, a unique souvenir of its efforts in connection with the exposition, in the form of a handsome card-case and memorandum book.

THE RAILWAYS AND LIGHT COMPANY OF AMERICA, 1500 Continental Trust Building, Baltimore, Md., advises the ELECTRICAL REVIEW that it is in the market for electric railway and lighting supplies, and that it will be glad to be placed on the mailing list of manufacturers in these lines.

THE DIEHL MANUFACTURING COMPANY, Elizabethport, N. J., is producing a special combination of Diehl enclosed motor and exhaust wheel. The set is designed with particular care for the accomplishment of successful operation. This company issues a catalogue giving full description and information of these motors connected to different makes of wheels and blowers.

THE NIAGARA FALLS POWER COMPANY is distributing a very neat and comprehensive pamphlet upon the application and use of its power on the Niagara frontier. Manufacturers can obtain this power for any purpose and in any quantity in Niagara Falls, the Tonawandas or Buffalo. The shipping facilities of the Niagara frontier are unsurpassed, and factory sites are available for any purpose.

THE MYERS GROUND LOCATOR is an instrument designed for use in locating grounds, losses and loose connections on electric circuits. This instrument, it is claimed, will replace voltmeters and Murray and Varley loop tests for the purpose. It is almost instantaneous in operation, is unaffected by earth currents and variations in the grounds and is exceedingly compact and simple. It is made by the Myers Break Finder Company, 105 South Warren street, Syracuse, N. Y.

THE STANDARD PAINT COMPANY, of New York and Chicago, which manufactures the well-known P & B goods, has issued a very attractive invitation to its friends and patrons to visit the P & B pavilion at the Pan-American Exposition, and to use same as a mail depot as well as a place for keeping appointments with friends or business acquaintances. The company has installed a very interesting exhibit of its famous Ruberoid roofing, insulating and building papers, as well as its preservative paints and electrical compounds. It reports a good business in every department.

THE GLOBE AUTOMATIC TELEPHONE COMPANY, of Chicago, Ill., has recently completed an exchange at George, Iowa. It is also constructing several other exchanges. Many favorable letters have been received by the company from those who have used the Globe automatic telephone system. They express their complete satisfaction with its workings. Owing to the small number required to operate the system when it is once installed, the decrease in the expense account from that of the ordinary telephone system is very satisfactory to those who receive the dividends. The company reports that orders are coming in very rapidly.

THE WESTERN ELECTRICAL SUPPLY COMPANY, of St. Louis, has recently issued a pocket-size net price list and discount sheet applying to its general catalogue No. 22. This is one of the most complete price lists ever issued in the electrical business, covering, as it does, practically all goods of standard make which pertain in any way to electricity. The book is bound in heavy linen covering, consisting of about 125 pages, and is suitable for carrying in the pocket. It should prove of great use and convenience to any one wishing to always have with him prices that are right. The company is sending this book out to the trade, and it will be mailed on application.

D. & W. ENCLOSED FUSES are finding wide use for a large variety of work. The use of enclosed fuses is becoming so general by those experienced in this line that the attention of the National Board of Fire Underwriters has been attracted by their protecting qualities. Overcoming the flash of the old style open fuses affords a great protection to property and lessens fire risk to a minimum, therefore the adoption of enclosed fuses by the National Board of Fire Underwriters will be greatly appreciated by electrical and business men in general. The Central Electric Company, of Chicago, are agents for the D. & W. enclosed fuses and other safety devices, and on request will be pleased to furnish bulletins and prices to those interested.

List of Electrical Patents Issued Last Week

[Specially reported for this journal by E. S. Duvall, solicitor of patents, Loan and Trust Building, Washington, D. C. Copies of any patent may be secured for 10 cents each.]

ISSUED JULY 23, 1901.

678,851 Apparatus for electrolysis of salts of alkali metals; H. Anderson, Springfield Mass.

678,853 Motor-control system; A. H. Armstrong, Schenectady, N. Y.—A circuit-control for a plurality of alternating-current induction-motors, means for connecting the motors in tandem with one or another of said motors.

678,854 Control of induction-motors; A. H. Armstrong, Schenectady, N. Y.—The method of equalizing the heating of induction motors operated in tandem, which consists in changing from time to time the relative positions of the motors in the tandem connections.

678,861 System of motor control; F. E. Case, Schenectady, N. Y.

678,864 Coil-retaining device; J. T. H. Dempster, Schenectady, N. Y.—A dynamo-electric machine having coil-retaining slots and composite slot-closing devices of magnetic and non-magnetic material.

678,873 Electric-arc lamp; J. A. Heany, Philadelphia, Pa.

678,874 Electric motor; J. A. Heany, Philadelphia, Pa.—A series of field magnets, each divided into two sections or poles, each field magnet section having two windings oppositely arranged and a commutator adapted to connect either windings or both windings with the main circuit.

678,875 Electric motor; J. A. Heany, Philadelphia, Pa.

678,876 Electric arc lamp; J. A. Heany, Philadelphia, Pa.

678,878 Locating grounds on electric circuits; E. M. Hewlett, Schenectady, N. Y.—Means of locating the position in the circuit of a ground, comprising a generator having one pole grounded, connections in parallel between the other pole and the sides of the circuit, and means for determining the relative resistance of the two branches of the system to the point at which a ground may exist.

678,881 Circuit-breaker; C. E. Holmes, Lynn, Mass.—Comprises an elastically-seated contact mounted on a movable plug, a socket-contact adapted to frictionally engage the same and a sliding electric connection between a plug-contact and a flexible terminal.

678,887 Resistance device; C. W. Larson, Schenectady, N. Y.—Comprises carbon rods provided with a thin sheath of incombustible heat-

(Continued on page 32.)

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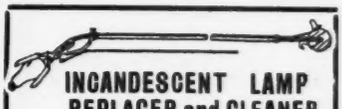

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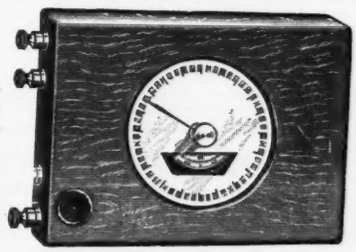

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The *ELECTRICAL REVIEW* during twenty years of existence has built up such a circulation that it is comprehensive of the best electrical interests throughout this and foreign countries. Its foreign circulations are worthy the consideration of advertisers.

PATENTS.

(Continued from page 31.)

conducting and electric insulating material, substantially as described, said rods being retained within a body of metal by a suitable heat-conducting and electric insulating material.

678,894 Trolley-signal; C. H. Morse, Cambridge, Mass.

678,904 Dynamo-electric machine; E. W. Rice, Jr., Schenectady, N. Y.

678,905 Controlling high potential circuits; E. W. Rice, Jr., Schenectady, N. Y.

678,914 Controller for electric motors; E. W. Stull, Johnstown, Pa.—A controller-casing having a movable portion, a blow-out coil attached to and movable with said portion.

678,916 Electric arc lamp; E. Thomson, Swampscott, Mass.

678,920 Lamp socket; J. C. Tournier, Schenectady, N. Y.

678,925 High or low-water alarm; C. E. Zimmerman, Syracuse, N. Y.

678,929 Electric meter; J. H. Barker, Cambridge, England.

678,951-2 Electric arc lamp; J. A. Heany, Philadelphia, Pa.

678,953 Electric clock; Geo. Hookham, Birmingham, England.

678,957 Electrical instrument; J. F. Kelly, Pittsfield, Mass.

678,964 Commutator for dynamo-electric machines; F. A. Merrick, Johnstown, Pa.

678,972 Telephone transmitter; J. G. Nolen, Chicago, Ill.

678,989 Controller for electric motors; E. W. Stull, Johnstown, Pa.

678,990 Cut-out block; H. O Swoboda, New York, N. Y.

678,991 Circuit-breaker; H. P. Ball, New York, N. Y.

678,998 System of electrical distribution; H. E. Heath, Windsor, Ct.

679,004 Automatic electric stop for elevators; H. B. Newhall, Jr., Plainfield, N. J.

679,006 System of electrical distribution; E. W Rice, Jr., Schenectady, N. Y.—A dynamo-electric machine, a plurality of distinct multiphase circuits directly connected to a single closed winding on said machine and inductively connected to a single multiphase circuit.

679,008 System of electrical distribution; C. P. Steinmetz, Schenectady, N. Y.—A dynamo-electric machine, a plurality of separate windings on said machine, and separate multiphase circuits connected respectively to said windings and inductively to a single multiphase circuit.

679,029 Calling device for telephone exchanges; F. A. Lundquist, Chicago, Ill.

679,041 Electrical sparking device for explosive engines; R. Varley, Jr., Jersey City, N. J.

679,057 Junction box and adapter for electrical installation; J. Meehan, Brooklyn, N. Y.

679,068 Apparatus for telephone lines; A. M. Bullard, Chicago, Ill.

679,092 System of electrical distribution; C. P. Steinmetz, Schenectady, N. Y.

679,102 System of electrical distribution; E. J. Berg, Schenectady, N. Y.—A device across which a constant difference of potential is maintained, reactances of different sign connected in series across said device, and a consumption-circuit connected between the junction of said reactances and a point between the terminals of said device

679,138 Electric metering system; L. Bell, Newton Centre, Mass A supply circuit, an electric motor a starting device, and means for disabling the normal operation of the starting device during time periods regulable by the supply company.

679,151 Combined switch and circuit-breaker; T. J. Johnston, Schenectady, N. Y.

670,174 Power-factor meter; P. M. Lincoln, Niagara Falls, N. Y.

679,175 Frequency or speed indicating and regulating device; P. M. Lincoln, Niagara Falls, N. Y.

679,197 Electrically-operated gas-burner; H. W. Webb, Columbus, Ohio.

679,206 Locking-socket for incandescent electric lamps; C. R. Barrett, Chicago, Ill.

679,253 Process of obtaining volatile elements from their compounds; A. H. Cowles, Cleveland, Ohio.

679,284 Armature-winding; William Lau, Berlin, Germany.

REISSUE.

11,922 Telephone circuits; P. G. Burgess, Mexico, Mex.

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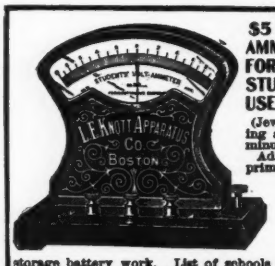

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New Wabash Equipment.

The Wabash Railroad has just received and placed in service on its lines running out of Chicago the following new equipment: Eight Combination Baggage and Passenger Coaches, thirty Palace Day Coaches, ten Reclining Chair Cars, three Café Cars and two Dining Cars. The majority of these new cars are seventy feet in length, and fitted with the latest style wide vestibules. They have six-wheel trucks with steel wheels. The cars are finished in the finest selected St Jago mahogany. The lighting is by Pintsch gas with the exception of the café, dining and some of the chair cars, which are unusually well lighted by electricity, the fixtures being especially designed for these cars. The dining cars will seat twenty-nine persons and have ample kitchen space. The café cars will seat eighteen persons, and have a library and smoking room in the observation end of the car which will seat fourteen persons. These cars also contain a private café with seating capacity for eight persons. These new cars represent the highest stage of development of modern car building Nothing has been omitted and no expense spared that would add to their luxurious elegance, or to the comfort and convenience of the patrons of the Wabash road.

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